SWEDISH
LIFE CYCLE
CENTER

CPM LCA Database
Life Cycle Inventory Datasets

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CPM LCA Database - Life Cycle Inventory Datasets

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The CPM LCA Database – Life Cycle Inventory Datasets.

This report contains all 748 complete LCI datasets in the CPM LCA Database as published in 2020-11-20.

Contents:

For information about the database please refer to the Swedish Life Cycle Center, lifecyclecenter.se.

Table 1. List of all life cycle inventory datasets in the CPM LCA Database as of 2020-11-20 in allphabetical order.

#	Process name	Technical scope	Product or service	Date Completed	CPM Quality
1	″Other″ electronic components assembly	Gate to gate	Other electronic components	2000-03-15	A
2	Air-and-water air conditioning system. ESA-DBP	Cradle to gate	Treatment and the distribution of totally 34 m3/s airflow for 17000 m2 landscape office area, when the cooling loads are totally 1189 MWh/year.	2007	S
3	Airbag's can production. Autoliv ESA-DBP	Gate to gate	Can	2010-07-08	S
4	Airbag's cushion manufacturing. Autoliv ESA-DBP	Gate to gate	Cushion	2010-07-08	S
5	Airbag's igniter granules manufacturing. Autoliv ESA-DBP	Unit operation	Igniter granules	2010-07-08	S
6	Airbag's inflator assembly. Autoliv ESA-DBP	Unit operation	Inflator	2010-07-08	S
7	Airbag's initiator assembly. Autoliv ESA-DBP	Unit operation	Initiator	2010-07-08	S
8	Airbag's label manufacturing. Autoliv ESA-DBP	Gate to gate	Label	2010-07-08	S
9	Airbag's nut manufacturing. Autoliv ESA-DBP	Gate to gate	Nut	2010-07-08	S
10	Airbag's shunt ring. Autoliv ESA-DBP	Gate to gate	Shunt ring	2010-07-08	S
11	Air-conditioning system. ESA-DBP	Cradle to gate	Air-conditioning system which conditions and distributes a variable airflow volume (VAV) of a max. 5 m3/s	2007	S
12	All-air air handling unit with a cooling coil and vapour compression chiller with a refrigerant. ESA	Cradle to grave	″One air handling unit, which distributes a constant airflow volume (CAV) of 4.8 m3/s 24h a day for 15 years.″	2007	S
13	All-air desiccant cooling air handling unit. ESA-DBP	Cradle to grave	″One air handling unit, which distributes a constant airflow volume (CAV) of 4.8 m3/s 24h a day for 15 years.″	2007	S
14	Aluminium recycling by refiners	Gate to gate	Aluminium ingot	2002-05-07	S
15	Anaerobic digestion of biological household waste. ESA-DBP	Gate to gate	Bio fertilizer; total Nitrogen Biogas	2006-2007	S
16	Australia, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
17	Austria, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
18	Belgium, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
19	Biofuel electricity energy system, EPD-version	Cradle to grave	Electricity	1996	S
20	Biogas from household waste, cradle-to-gate, no allocation - f3 fuels	Cradle to gate	Biogas from household waste	2013-11-30	A
21	Biogas from household waste, cradle-to-gate, system expansion, impact categories only - f3 fuels	Cradle to gate	Biogas from household waste	2013-11-30	A
22	Biogas from industrial waste, cradle-to-gate, no allocation - f3 fuels	Cradle to gate	Biogas from industrial waste	2013-11-30	A
23	Biogas from industrial waste, cradle-to-gate, system expansion, impact categories only - f3 fuels	Cradle to gate	Biogas from industrial waste	2013-11-30	A
24	Biogas from sewage sludge, cradle-to-gate, no allocation - f3 fuels	Cradle to gate	Biogas from sewage sludge	2013-11-30	A
25	Biogas from sewage sludge, cradle-to-gate, system expansion, impact categories only - f3 fuels	Cradle to gate	Biogas from sewage sludge	2013-11-30	A
26	Biogas from sugar beets, cradle-to-gate, no allocation - f3 fuels	Cradle to gate	Biogas from sugar beets	2013-11-30	A
27	Biogas from sugar beets, cradle-to-gate, system expansion, impact categories only - f3 fuels	Cradle to gate	Biogas from sugar beets	2013-11-30	A
28	Biogasification of solid municipal waste	Gate to gate	Compost	2002-08-14	S

29	Bore-hole based air-conditioning system. ESA-DBP	Cradle to grave	Air-conditioning system which conditions and distributes a variable airflow volume (VAV) of a max. 5 m3/s	2007	S
30	Cable assembly	Gate to gate	Cables	2000-03-08	S
31	Canada, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
32	Capacitor for hole mounting assembly	Gate to gate	Capacitor for hole mounting	2000-03-15	S
33	Capacitor for surface mounting assembly	Gate to gate	Capacitor for surface mounting	2000-03-08	S
34	Cardboard production (MDF based). ESA-DBP	Gate to gate	Cardboard	1997	A
35	Cargo vessel, medium-sized (8´-2´ dwt)	Gate to gate	Cargo	1998 08	S
36	Cargo vessel, small (<2´dwt)	Gate to gate	Cargo	1998 08	S
37	Cargo vessels, large (>8´ dwt)	Gate to gate	Cargo	1998 08	S
38	Cast iron production. ESA-DBP	Gate to gate	Cast iron	1996	S
39	Casting of iron, type V10	Unit operation	Cast iron	02-12-31	S
40	CBG combustion in heavy duty truck or bus, spark ignition engine, Euro V, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
41	CBG combustion in heavy duty truck or bus, spark ignition engine, Euro VI, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
42	Cement production	Cradle to gate	Cement	1997-05-01	S
43	Clay roof tile manufacturing. ESA-DBP	Cradle to gate	Tiles	1993	A
44	Cleaning and blastering of cast iron	Unit operation	Cast iron	02-12-31	S
45	Cleaning of bearing roller	Unit operation	roller	2002-12-12	S
46	Cleansing of glass containers	Gate to gate	Glass container	1991-01-01	U
47	Cleansing of juice bottles	Gate to gate	Juice bottles	1991-01-01	U
48	Clearing of young forest	Gate to gate	Young forest area	1998-02-13	A
49	CNG combustion in heavy duty truck or bus, spark ignition engine, Euro V, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
50	CNG combustion in heavy duty truck or bus, spark ignition engine, Euro VI, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
51	Coal fired plant for heat and power production - Large plant	Gate to gate	Heat	2000-07-07	S
52	Coal mining and cleaning. ESA-DBP	Gate to gate	Coal	1996	S
53	Coarse mortar production	Gate to gate	Coarse mortar	1996-10-01	A
54	Coastal shipping	Unit operation	Cargo	1994-04-01	S
55	Cold reducing of steel sheets	Unit operation	Cold reduced steel sheet	02-12-31	S
56	Collection area driving, with diesel driven waste collection vehicle. ESA-DBP	Unit operation	1 h of collection area driving	2005	A
57	Collection area driving, with gas driven waste collection vehicle. ESA-DBP	Unit operation	1 h of collection area driving	2005	A
58	Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP	Unit operation	1 h of collection area driving	2005	A
59	Collection stop, with diesel driven waste collection vehicle. ESA-DBP	Unit operation	1 h of collection stop	2005	A
60	Collection stop, with gas driven waste collection vehicle. ESA-DBP	Unit operation	1 h of collection stop	2005	A
61	Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP	Unit operation	1 h of collection stop	2005	A
62	Combined heat and power plant (CFB-KVV) with support systems	Cradle to gate	Electricity	1996-12-01	S
63	Combined heat and power plant (GCC-KVV) with support systems	Cradle to gate	Electricity	1996-12-01	S
64	Combustion of bio fuel	Gate to gate	1 MJ	1991	U
65	Combustion of coal	Gate to gate	1 MJ	1991	U

66	Combustion of natural gas	Gate to gate	1 MJ	1991	U
67	Combustion of oil	Gate to gate	1 MJ	1991	U
68	Combustion of waste	Gate to grave	Thermal energy Electricity	1999-04-19	S
69	Combustion of waste oil	Unit operation	84 kg oil	2002-12-18	S
70	Combustion of waste to generate heat and electricity	Gate to gate	District heating Electricity	1996-03-01	S
71	Composting of solid municipal waste	Gate to gate	Compost	2002-08-14	S
72	Connector assembly	Gate to gate	Connectors	2000-03-09	S
73	Construction of liquid composting batch system. ESA-DBP	Gate to gate	person·year	1997	S
74	Construction of liquid composting continous system. ESA-DBP	Gate to gate	person·year	1997	S
75	Construction of small-scale waste water treatment plant. ESA-DBP	Gate to gate	person·year	1997	S
76	Converting waste-oil into fuel oil AGGR	Gate to gate	Electricity/Heat Converted fuel oil	1999	S
77	Copper alloy casting of block metal from scrap	Gate to gate	1 kg block metal	1995	U
78	Copper casting and drawing to 0.06mm wire	Gate to gate	1 kg 0,06 mm copper wire	1995	U
79	Copper casting and drawing to 0.6mm wire	Gate to gate	1 kg of 0.6 mm copper wire	1995	U
80	Copper casting and drawing to 8mm wire	Gate to gate	1 kg of 8mm copper wire	1995	U
81	Copper casting, drawing and laquering to 0.6mm wire	Gate to gate	1 kg 0,6 mm laquer coated copper wire	1995	U
82	Copper casting, drawing and polmer coating to 0.6mm wire	Gate to gate	1 kg 0,6 mm polymer coated copper wire	1995	U
83	Copper continuous casting	Gate to gate	1 kg of cast copper	1995	U
84	Copper extrusion and drawing to profiles	Gate to gate	1 kg extruded copper profiles	1995	U
85	Copper extrusion and drawing to tubes	Gate to gate	1 kg of extruded and drawn copper tubes	1995	U
86	Copper ore concentrate preparation and delivery	Cradle to gate	copper ore concentrate	1998	A
87	Copper ore mining	Cradle to gate	Copper ore	1998	A
88	Copper ore mining and concentration	Cradle to gate	1 kg copper in concentrate	1995	U
89	Copper production	Cradle to gate	kg	1996-05-01	S
90	Copper rolling to strips	Gate to gate	1 kg of rolled copper strip	1995	U
91	Copper skew rolling, pilgering and drawing to tubes	Gate to gate	1 kg of pilgered copper tubes	1995	U
92	Cotton (conventional) fibres production. ESA-DBP	Gate to gate	cotton fibres	2004	S
93	Cotton covering of sofa. ESA-DBP	Cradle to grave	″The functional unit was: surface covering of a 3-seat sofa for private use during 10 years.″ For cotton fabric it is 4.99 kg per sofa.	2004	S
94	Crushing and cleaning of broken glass	Gate to gate	Crushed, cleaned glass	1991-01-01	U
95	Cultivation and felling of trees for papermaking. ESA-DBP	Cradle to gate	Birchwood	1997	A
96	CuNi10Fe extrusion and drawing of tubes	Gate to gate	1 kg CuNi10Fe tubes	1995	U
97	CuNi10Fe extrusion and pilgering of tubes	Gate to gate	1 kg CuNi10Fe tubes	1995	U
98	CuNi10Fe semicontinuous casting	Gate to gate	1 kg of cast CuNi10Fe	1995	U
99	CuSn6 casting and drawing to wire	Gate to gate	1 kg CuSn6 wire	1995	U
100	CuSn6 casting and rolling to strips	Gate to gate	1 kg CuSn6 strips	1995	U
101	CuSn6 continuous casting	Gate to gate	1 kg cast CuSn6	1995	U
102	Cutting of steel bars (117x147 mm)	Unit operation	Cut steel bar	02-12-31	S
103	CuZn37 casting and drawing to wire	Gate to gate	1 kg CuZn37 wire	1995	U
104	CuZn37 casting and extruding over core to tubes	Gate to gate	1 kg CuZn37 tubes	1995	U
105	CuZn37 casting and rolling to strips	Gate to gate	1 kg CuZn37 strips	1995	U
106	CuZn37 continuous casting	Gate to gate	1 kg cast CuZn37	1995	U

107	CuZn37Pb chill casting	Gate to gate	1 kg cast CuZn37Pb	1995	U
108	CuZn39Pb2 casting and pressing to rods	Gate to gate	1 kg CuZn39Pb2 bars	1995	U
109	Czech Republic, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
110	Delivery van, distribution, diesel	Gate to gate	Cargo	1998 - 08	S
111	Delivery van, distribution, petrol	Gate to gate	Cargo	1998 - 08	S
112	Denmark, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
113	De-watering of water-sludge	Gate to gate	1 m3 of recieved water-sludge from Reci Industri Halmstad.	1999-04-19	S
114	Diesel combustion	Gate to gate	Diesel energy	1991-01-01	U
115	Diesel driven freight train, future	Unit operation	Cargo	1997-11-19	S
116	Diesel driven freight train, T44 engine	Unit operation	Cargo	1997-11-19	S
117	Diesel EN590, EU-15, cradle-to-gate, energy allocation - f3 fuels	Cradle to gate	Diesel EN590	2013-11-30	A
118	Diesel engine, Euro 0	Unit operation	Mechanical work	1997-11-19	S
119	Diesel engine, Euro 1	Unit operation	Mechanical work	1997-11-19	S
120	Diesel engine, Euro 2	Unit operation	Mechanical work	1997-11-19	S
121	Diesel engine, future	Unit operation	Mechanical work	1997-11-19	S
122	Diesel MK1, cradle-to-gate, energy allocation - f3 fuels	Cradle to gate	Diesel MK1	2013-11-30	A
123	Diesel production	Cradle to gate	Diesel	1996-01-01	U
124	Diesel propulsed train	Unit operation	Cargo	1999 - 11	S
125	Dioctyl phthalate (DOP) production. ESA-DBP	Gate to gate	dioctyl phthalate	1992	A
126	Dioctyl phthalate (DOP) production. ESA-DBP	Gate to gate	DOP	1997	A
127	Diode wafer production and assembly	Gate to gate	Diodes	2000-03-02	S
128	Dismounting of bearing	Unit operation	1.2 ton bearing	2002-12-18	A
129	Disposal of polyethylene to landfill.	Gate to grave	1000 kg of polyethylene	2003-01-10	S
130	Dry wood chips fired plant for heat and power production - Large plant	Gate to gate	Heat	1999-08-30	S
131	ED95 - Sugar cane, cradle-to-gate, energy allocation, impact categories only - f3 fuels	Cradle to gate	ED95 from sugar cane	2013-11-30	A
132	ED95 - Sugar cane, cradle-to-gate, system expansion, impact categories only - f3 fuels	Cradle to gate	ED95 from sugar cane	2013-11-30	A
133	ED95 - Wheat, cradle-to-gate, energy allocation - f3 fuels	Cradle to gate	ED95 from wheat	2013-11-30	A
134	ED95 - Wheat, cradle-to-gate, system expansion, impact categories only - f3 fuels	Cradle to gate	ED95 from wheat	2013-11-30	A
135	ED95 combustion in heavy duty truck or bus with a diesel engine, Euro V, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
136	ED95 combustion in heavy duty truck or bus with a diesel engine, Euro VI, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
137	Electric freight train, waggon load	Gate to gate	Cargo	99 - 11 -	S
138	Electric freight train, waggon load, including electricity production	Gate to gate	Cargo	99 - 11 -	S
139	Electrically driven combi train, future	Unit operation	Cargo	1997-11-19	S
140	Electrically driven combi train, RC engine	Unit operation	Cargo	1997-11-19	S
141	Electrically driven freight train 230 metres, future	Unit operation	Cargo	1997-11-19	S
142	Electrically driven freight train 230 metres, RC engine	Unit operation	Cargo	1997-11-19	S

143	Electrically driven freight train 700 metres, future	Unit operation	Cargo	1997-11-19	S
144	Electrically driven freight train 700 metres, RC engine	Unit operation	Cargo	1997-11-19	S
145	Electrically driven Intermodal train, RC engine	Gate to gate	Cargo	99 - 11 -	S
146	Electrically driven intermodal train, RC engine, including electricity production	Unit operation	Cargo	99 - 11 -	S
147	Electrically driven system train (Circuit-working), RC engine	Unit operation	Cargo	99 - 11 -	S
148	Electrically driven system train (Circuit-working), RC engine, including electricity production	Unit operation	Cargo	99 - 11 -	S
149	Electrically driven system train, future	Unit operation	Cargo	1997-11-19	S
150	Electrically driven system train, RC engine	Unit operation	Cargo	1997-11-19	S
151	Electricity production and distribution - India - Regionalized	Gate to gate	Electricity	2016-12-12	
152	Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP	Gate to gate	Aluminium capacitor	2010-08-05	U
153	Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP	Gate to gate	Connector	2010-08-05	U
154	Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP	Gate to gate	Housing	2010-08-05	U
155	Electronic Control Unit's inductor choke manufacturing. Autoliv ESA-DBP	Gate to gate	Inductor choke	2010-08-05	U
156	Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP	Gate to gate	Integrated circuit ASIC	2010-08-05	U
157	Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP	Gate to gate	Integrated circuit comparator	2010-08-05	U
158	Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP	Gate to gate	Integrated circuit interface	2010-08-05	U
159	Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP	Gate to gate	Integrated circuit MCU	2010-08-05	U
160	Electronic Control Unit's label manufacturing. Autoliv ESA-DBP	Gate to gate	Label	2010-08-05	U
161	Electronic Control Unit's MEMS based sensor manufacturing. Autoliv ESA-DBP	Gate to gate	Sensor	2010-08-05	U
162	Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP	Gate to gate	PCB board	2010-08-05	U
163	Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP	Gate to gate	Diode rectifier	2010-08-05	U
164	Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP	Gate to gate	Resistor thick film	2010-08-05	U
165	Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP	Gate to gate	Resonator	2010-08-05	U
166	Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP	Gate to gate	Schottky diode	2010-08-05	U
167	Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP	Gate to gate	Screw	2010-08-05	U
168	Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP	Gate to gate	Signal diode	2010-08-05	U
169	Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP	Gate to gate	Transistor	2010-08-05	U
170	Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP	Gate to gate	TVS diode	2010-08-05	U
171	Ethanol from sugar beets, cradle-to-gate, energy allocation - f3 fuels	Cradle to gate	Ethanol from sugar beets	2013-11-30	A
172	Ethanol from sugar beets, cradle-to-gate, system expansion, impact categories only - f3 fuels	Cradle to gate	Ethanol from sugar beets	2013-11-30	A

173	Ethanol from sugar cane, cradle-to-gate, energy allocation, impact categories only - f3 fuels	Cradle to gate	Ethanol from sugar cane	2013-11-30	A
174	Ethanol from sugar cane, cradle-to-gate, system expansion, impact categories only - f3 fuels	Cradle to gate	Ethanol from sugar cane	2013-11-30	A
175	Ethanol from wheat, cradle-to-gate, energy allocation - f3 fuels	Cradle to gate	Ethanol from wheat	2013-11-30	A
176	Ethanol from wheat, cradle-to-gate, system expansion, impact categories only - f3 fuels	Cradle to gate	Ethanol from wheat	2013-11-30	A
177	Ethylene production from cane based ethanol. ESA-DBP	Gate to gate	Ethylene	2009	S
178	European average production of sodium carbonate (Solvay process)	Gate to gate	Sodium carbonate	2003-03-10	S
179	European Union, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
180	Exterior coating (Swedish red paint) maintenance. ESA-DBP	Gate to gate	Maintenance	1999	A
181	Extraction and beneficiation of rock phosphate	Other	Rock phosphate	99-01-25	A
182	Extraction and grinding of dolomite	Other	Dolomite	1999-01-25	A
183	Extraction and processing of natural gas (NG). ESA-DBP	Cradle to gate	1 Nm3 processed natural gas	1999	A
184	Extraction of crude oil	Cradle to gate	Crude oil	1991	U
185	Extraction of crude oil and gas	Cradle to gate	Crude oil Gas	1994	S
186	Extraction of dolomite	Cradle to gate	Dolomite	1991-01-01	U
187	Extraction of dolomite	Other	Dolomite	1999-01-25	A
188	Extraction of feldspar	Cradle to gate	Feldspar	1991-01-01	U
189	Extraction of lime	Cradle to gate	Lime	1991-01-01	U
190	Extraction of Portland soda	Cradle to gate	Portland soda	1991-01-01	U
191	Extraction of sand	Cradle to gate	Sand	1991-01-01	U
192	Extraction of sulphur and production of sulphuric acid	Other	H2SO4	99-01-25	A
193	Extraction to ABS APME	Cradle to gate	ABS	1999	S
194	Extraction to polycarbonate APME	Cradle to gate	Polycarbonate	1997	A
195	Extraction to polyethylene all grades APME	Cradle to gate	Polyethylene all grades	1993	A
196	Extraction to polyethylene HD APME	Cradle to gate	Polyethylene HD	1999	S
197	Extraction to polyethylene LD APME	Cradle to gate	Polyethylene LD	1999	S
198	Extraction to polyethylene linear LD APME	Cradle to gate	Polyethylene LD	1999	S
199	Extraction to SAN APME	Cradle to gate	SAN	1999	S
200	Extraction to toluene APME	Cradle to gate	Toluene	1999	S
201	Extraction to xylene APME	Cradle to gate	Xylene	1999	S
202	Extraction, beneficiation and grinding of kieserite	Other	Kieserite	99-01-25	A
203	Extraction, beneficiation and grinding of potash salt	Other	Potassium chloride	99-01-25	A
204	Fabrication of oil filters	Cradle to gate	Filter Pall HC 8904 FKP 16Z	2002-12-12	S
205	Ferry	Gate to gate	Cargo	1998 08	S
206	Ferry, 700-7000 tonnes	Unit operation	Cargo	1997-11-19	S
207	Ferry, 700-7000 tonnes, future	Unit operation	Cargo	1997-11-19	S
208	Fertilizing in silviculture	Gate to gate	Fertilized forest area	1994-02-24	A

209	Final felling	Gate to gate	Final felling softwood Forest land	1998-02-13	A
210	Finland, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
211	Flame laminate treatment of textiles	Gate to gate	Laminated textile	1997-03-01	A
212	Flame retardant polyester (Trevira CS) covering of sofa. ESA-DBP	Cradle to grave	"The functional unit was: surface covering of a 3-seat sofa for private use during 10 years." For Trevira CS fabric it is 3.56 kg per sofa.	2004	S
213	Flexible PUR foam	Gate to gate	Flexible	1996	A
214	Floor maintenance. ESA-DBP	Gate to gate	Floor maintenance	1999	A
215	Forging of ingot into steel bars, 350 mm	Gate to gate	Forged Bars	02-12-31	S
216	Forwarding of harvested wood	Gate to gate	Softwood at roadside	1998-02-13	A
217	Fossil diesel - EN590 combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
218	Fossil diesel - EN590 combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
219	Fossil diesel - MK1 combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
220	Fossil diesel - MK1 combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
221	France, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
222	Freight plane, MD-82	Unit operation	Cargo	1997-11-19	S
223	Freight plane, MD-82	Unit operation	Cargo	1997-11-19	S
224	Freighter, 2000-8000 dwt	Unit operation	Cargo	1997-11-19	S
225	Freighter, 2000-8000 dwt, future	Unit operation	Cargo	1997-11-19	S
226	Freighter, larger than 8000 dwt	Unit operation	Cargo	1997-11-19	S
227	Freighter, larger than 8000 dwt, future	Unit operation	Cargo	1997-11-19	S
228	Freighter, smaller than 2000 dwt	Unit operation	Cargo	1997-11-19	S
229	Freighter, smaller than 2000 dwt, future	Unit operation	Cargo	1997-11-19	S
230	Freight-Train Luleå to Halmstad	Gate to gate	Waste oil	1999-04-20	A
231	Freight-Train Umeå to Halmstad	Gate to gate	Waste oil	1999-04-20	A
232	Fuel gas electricity energy system, EPD-version	Cradle to grave	Electricity	1996-10	S
233	Fuel gas electricity energy system, ETH - full version	Cradle to grave	Electricity	1996-10	S
234	Gas-turbine power plant with support systems	Cradle to gate	Electricity	1996-12-01	S
235	General Purpose Polystyrene (GPPS)	Cradle to gate	PS	1993	A
236	General Purpose Polystyrene (GPPS)	Cradle to gate	PS	1997	A
237	Germany, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
238	Glassworks	Gate to gate	Glass	1991-01-01	U
239	Glulam wood production	Cradle to gate	Glulam wood	1997-05-01	A
240	Greece, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
241	Grinding of bearing rollers	Unit operation	bearing roller	02-12-31	A
242	Grinding of dolomite	Gate to gate	Dolomite	99-01-25	A
243	Handpolishing of bearing rollers	Unit operation	bearing roller	02-12-31	A
244	Heating of ingot at the rolling mill	Unit operation	Ingots	02-12-31	S
245	Heating of smelt iron in a holding furnace	Unit operation	Iron	02-12-31	S

246	Heavy truck with international semitrailer, max 40 tonnes, future	Unit operation	Cargo	1997-11-19	S
247	Heavy truck with international semitrailer, max 40 tonnes, manufactured after 1996 [Euro 2]	Unit operation	Cargo	1997-11-19	S
248	Heavy truck with international semitrailer, max 40 tonnes, manufactured before 1992 [Euro 0]	Unit operation	Cargo	1997-11-19	S
249	Heavy truck with international semitrailer, max 40 tonnes, manufactured between 1992 and 1995[Euro1]	Unit operation	Cargo	1997-11-19	S
250	Heavy truck with one trailer, long distance, Euro 0	Gate to gate	Cargo	1998 - 08	S
251	Heavy truck with one trailer, long distance, Euro 1	Gate to gate	Cargo	1998 - 08	S
252	Heavy truck with one trailer, long distance, Euro 2	Gate to gate	Cargo	1998 - 08	S
253	Heavy truck with one trailer, long distance, made before 1990	Gate to gate	Cargo	1998 - 08	S
254	Heavy truck with trailer, max 60 tonnes, future	Unit operation	Cargo	1997-11-19	S
255	Heavy truck with trailer, max 60 tonnes, manufactured after 1996 [Euro 2]	Unit operation	Cargo	1997-11-19	S
256	Heavy truck with trailer, max 60 tonnes, manufactured before 1992 [Euro 0]	Unit operation	Cargo	1997-11-19	S
257	Heavy truck with trailer, max 60 tonnes, manufactured between 1992 and 1995 [Euro1]	Unit operation	Cargo	1997-11-19	S
258	Heavy truck with two trailers, long distance, Euro 0	Gate to gate	Cargo	1998 - 08	S
259	Heavy truck with two trailers, long distance, Euro 1	Gate to gate	Cargo	1998 - 08	S
260	Heavy truck with two trailers, long distance, Euro 2	Gate to gate	Cargo	1998 - 08	S
261	Heavy truck with two trailers, long distance, made before 1990	Gate to gate	Cargo	1998 - 08	S
262	Heavy truck, max 18 tonnes, future	Unit operation	Cargo	1997-11-19	S
263	Heavy truck, max 18 tonnes, manufactured after 1996 [Euro 2]	Unit operation	Cargo	1997-11-19	S
264	Heavy truck, max 18 tonnes, manufactured before 1992 [Euro 0]	Unit operation	Cargo	1997-11-19	S
265	Heavy truck, max 18 tonnes, manufactured between 1992 and 1995 [Euro1]	Unit operation	Cargo	1997-11-19	S
266	Heavy truck, max 24 tonnes, future	Unit operation	Cargo	1997-11-19	S
267	Heavy truck, max 24 tonnes, manufactured after 1996 [Euro 2]	Unit operation	Cargo	1997-11-19	S
268	Heavy truck, max 24 tonnes, manufactured before 1992 [Euro 0]	Unit operation	Cargo	1997-11-19	S
269	Heavy truck, max 24 tonnes, manufactured between 1992 and 1995 [Euro1]	Unit operation	Cargo	1997-11-19	S
270	High purity copper production from primary raw materials	Gate to gate	1 kg pure copper	1995	U
271	High purity copper production from secondary raw materials	Gate to gate	1 kg of pure copper	1995	U
272	High sea shipping	Unit operation	Cargo	1994-04-01	S
273	Hot rolling of steel sheet	Gate to gate	Hot rolled steel sheet	02-12-31	S
274	Hungary, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
275	HVO combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
276	HVO combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
277	Hydro electricity energy system, EPD-version	Cradle to grave	Electricity	1996-10	S

278	Hydro electricity energy system, ETH - full version	Cradle to grave	Electricity	1996-10	S
279	Hydro-electric power station with support systems	Cradle to gate	Electricity	1996-12-01	S
280	Hydrogen fuel production by steam reforming of natural gas. ESA-DBP	Cradle to gate	CGH2	2002	S
281	Hydrogen fuel production from on-site electrolysis. ESA-DBP	Gate to gate	CGH2	2002	S
282	Hydrotreated Vegetable Oil - Palm oil, cradle-to-gate, system expansion - f3 fuels	Cradle to gate	HVO - Palm oil	2013-11-30	A
283	Hydrotreated Vegetable Oil - Rapeseed oil, cradle-to-gate, system expansion - f3 fuels	Cradle to gate	HVO - Rapeseed oil	2013-11-30	A
284	Iceland, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
285	Incineration of aluminium	Gate to gate	Thermal energy	1990	U
286	Incineration of biological household waste. ESA-DBP	Gate to grave	District heating Electricity	2006-2007	S
287	Incineration of corrugated board	Gate to gate	Thermal energy	1990	U
288	Incineration of linoleum	Gate to gate	Thermal energy	1990	U
289	Incineration of paperboard for liquids	Gate to gate	Thermal energy	1990	U
290	Incineration of polyethylene	Gate to gate	Thermal energy	1990	U
291	Incineration of polystyrene	Gate to gate	Thermal energy	1990	U
292	Incineration of PVC	Gate to gate	Thermal energy	1990	U
293	Incineration of starch	Gate to gate	Thermal energy	1990	U
294	Incineration of wood	Gate to gate	Thermal energy	1990	U
295	Inductor assembly	Gate to gate	Inductors	2000-03-13	S
296	Integrated circuit capsule assembly	Gate to gate	Integrated circuit capsule	2000-03-03	S
297	Inventory of Volvo painting plant, TB4	Gate to gate	Painted coach	1996-10-21	S
298	Ireland, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
299	Italy, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
300	Japan, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
301	Jet plane, A 300-B4, 1200 km	Gate to gate	Cargo	1999 - 12	S
302	Jet plane, A 300-B4, 600 km	Gate to gate	Cargo	1999 - 12	S
303	Jet plane, B727-200, 1200 km	Gate to gate	Cargo	1999 - 12	S
304	Jet plane, B727-200, 600 km	Gate to gate	Cargo	1999 - 12	S
305	Jet plane, B737-300QC, 1200 km	Gate to gate	Cargo	1999 - 12	S
306	Jet plane, B737-300QC, 600 km	Gate to gate	Cargo	1999 - 12	S
307	Jet plane, B747-400, 1200 km	Gate to gate	Cargo	1999 - 12	S
308	Jet plane, B747-400, 600 km	Gate to gate	Cargo	1999 - 12	S
309	K30 ready mixed concrete production	Gate to gate	K30-ready mixed concrete	1996-10-01	A
310	K40 ready mixed concrete production	Gate to gate	K40-ready mixed concrete	1996-10-01	A
311	Korea, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
312	Landfill disposal	Gate to grave	1 kg	1991	U
313	Landfilling of solid municipal waste	Gate to gate	Electricity Residual waste	2002-08-14	S
314	Laying of linoleum-floor	Gate to gate	Linoleum-floor	1994	U
315	Light truck, distribution, Euro 0	Gate to gate	Cargo	1998 - 08	S
316	Light truck, distribution, Euro 1	Gate to gate	Cargo	1998 - 08	S
317	Light truck, distribution, Euro 2	Gate to gate	Cargo	1998 - 08	S
318	Light truck, distribution, made before 1990	Gate to gate	Cargo	1998 - 08	S
319	Light truck, max 3,5 tonnes, diesel driven	Unit operation	Cargo	1997-11-19	S
320	Light truck, max 3,5 tonnes, gasoline driven	Unit operation	Cargo	1997-11-19	S
321	Light truck, max 8 tonnes, future	Unit operation	Cargo	1997-11-19	S

322	Light truck, max 8 tonnes, manufactured after 1996 [Euro 2]	Unit operation	Cargo	1997-11-19	S
323	Light truck, max 8 tonnes, manufactured before 1992 [Euro 0]	Unit operation	Cargo	1997-11-19	S
324	Light truck, max 8 tonnes, manufactured between 1992 and 1995 [Euro1]	Unit operation	Cargo	1997-11-19	S
325	Lignite electricity energy system, EPD-version	Cradle to grave	Electricity	1996-10	S
326	Lignite electricity energy system, ETH - full version	Cradle to grave	Electricity	1996-10	S
327	Limestone quarrying. ESA-DBP	Gate to gate	Limestone	1996	S
328	Linoleum flooring. ESA-DBP	Cradle to grave	Linoleum flooring	1994	S
329	Liquid crystal display unit assembly	Gate to gate	Display units	2000-03-01	S
330	Locomotive two-stroke engine	Unit operation	Mechanical work	1996-04-01	A
331	Luxembourg, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
332	Maintenance of train bearings - train type 'Regina'. ESA-DBP	Gate to gate	2 axleboxes with bearings on a distance of 100 000km	2003	S
333	Maintenance of train bearings - train type 'X1'. ESA-DBP	Gate to gate	2 axleboxes with bearings on a distance of 100 000km	2003	S
334	Maintenance of train bearings - train type 'X10'. ESA-DBP	Gate to gate	2 axleboxes with bearings on a distance of 100 000km	2003	S
335	Manufacturing of brass cages at SKFs site in Göteborg	Gate to gate	Brass cage	02-12-31	S
336	Manufacturing of CD-R (Compact Disc-Recordable). ESA-DBP	Gate to gate	CD-R (recordable disc)	1997	S
337	Manufacturing of CD-ROM (Compact Disc - Read Only Memory). ESA-DBP	Gate to gate	CD-ROM (read only memory disc)	1997	S
338	Manufacturing of Cold Rolled Steel Tubes, 41,55 x 37,21 or 47,75 x 41,01 mm	Gate to gate	Cold rolled steel tube	2002-08	S
339	Manufacturing of Hot Rolled Round Steel Billets, 80 mm	Gate to gate	Hot rolled round steel billets	2002-08	S
340	Manufacturing of Hot Rolled Square Billets, 150 mm	Gate to gate	Hot rolled square billets, 150mm	2000-01-14	S
341	Manufacturing of Hot Rolled Steel Tubes, 70,7 x 47,5 mm	Gate to gate	Hot rolled steel tube	2002-08	S
342	Manufacturing of plywood boxes at Nefab in Alfta	Gate to gate	plywood box	02-12-31	S
343	Manufacturing of polyurethane insulation	Gate to gate	pcs	1996-03-01	A
344	Manufacturing of SKF's Spherical Roller Bearing	Gate to gate	Spherical Roller Bearing	2000-01-18	S
345	Manufacturing of the Plain bearing GE30	Gate to gate	Plain Bearing GE30	2002-08	S
346	Manufacturing PU elastics	Unit operation	PU	1993-08-25	A
347	MDI - PUR precursors	Cradle to gate	MDI	1996	A
348	Medium speed, four-stroke diesel vessel engine	Unit operation	Mechanical work	1991-01-01	A
349	Medium speed, four-stroke diesel vessel engine	Unit operation	Mechanical work	1991-01-01	A
350	Medium weight truck, regional, Euro 0	Gate to gate	Cargo	1998 - 08	S
351	Medium weight truck, regional, Euro 1	Gate to gate	Cargo	1998 - 08	S
352	Medium weight truck, regional, Euro 2	Gate to gate	Cargo	1998 - 08	S
353	Medium weight truck, regional, made before 1990	Gate to gate	Cargo	1998 - 08	S
354	Metal coating of cold reduced steel sheets	Unit operation	Zinc coated steel sheet	02-12-31	S
355	Metal surface treatment of car- and boat details	Gate to gate	1995	1996-03-01	U
356	Mexico, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
357	Mining to sodium chloride APME	Cradle to gate	Sodium chloride	1994	S

358	Mining to sodium hydroxide APME	Cradle to gate	Sodium hydroxide	1994	S
359	Modified natural gas vehicle (NGV) operating on CNG with 15 % hydrogen (HCNG-15). ESA-DBP	Gate to gate	1 vehicle km	2003	A
360	Modified natural gas vehicle (NGV) operating on CNG with 30 % hydrogen (HCNG-30). ESA-DBP	Gate to gate	1 vehicle km	2003	A
361	Modified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP	Gate to gate	1 vehicle km	2003	A
362	Mounting of bearing	Unit operation	1.2 ton of bearing	2002-12-	A
363	Mounting profile production	Gate to gate	Mounting profile	1996-10-01	A
364	Natural gas fired combination plant for heat and power production	Gate to gate	Heat	1999-08-30	S
365	Natural gas fired combination power plant with support systems	Cradle to gate	Electricity	1996-12-01	S
366	Natural gas fired plant for heat production - Small plant	Gate to gate	Heat	1999-08-30	S
367	Natural gas fired plant with flue gas condensation for heat and power production	Gate to gate	Heat	1999-08-30	S
368	Natural gas, cradle-to-gate, unknown allocation - f3 fuels	Cradle to gate	Natural gas	2013-11-30	A
369	Netherlands, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
370	New Zealand, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
371	N-fertilizer production	Gate to gate	Nitrogen fertiliser	1996-11-14	U
372	Night vision camera assembly. Autoliv ESA-DBP	Unit operation	Camera	2010-07-15	S
373	Night vision camera's gasket manufacturing. Autoliv ESA-DBP	Gate to gate	Gasket	2010-07-15	A
374	Night vision camera's label manufacturing. Autoliv ESA-DBP	Gate to gate	Label	2010-07-15	S
375	Night vision camera's lens assembly. Autoliv ESA-DBP	Unit operation	Lens assembly	2010-07-15	S
376	Night vision camera's lens heater manufacturing. Autoliv ESA-DBP	Gate to gate	Lens heater	2010-07-15	S
377	Night vision camera's motor manufacturing. Autoliv ESA-DBP	Unit operation	Motor	2010-07-15	A
378	Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP	Gate to gate	Rear enclosure	2010-07-15	S
379	Night vision camera's screw manufacturing. Autoliv ESA-DBP	Gate to gate	Screw	2010-07-15	S
380	Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP	Gate to gate	Sensor retainer	2010-07-15	A
381	Night vision camera's shutter assembly. Autoliv ESA-DBP	Unit operation	Shutter	2010-07-15	S
382	Night vision camera's spring extension. Autoliv ESA-DBP	Gate to gate	Spring extension	2010-07-15	S
383	Night vision camera's thermistor manufacturing. Autoliv ESA-DBP	Gate to gate	Thermistor	2010-07-15	S
384	Norway, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
385	Nuclear electricity energy system, EPD-version	Cradle to grave	Electricity	1996-10	S
386	Nuclear electricity energy system, ETH - full version	Cradle to grave	Electricity	1996-10	S
387	Nuclear power plant with support systems	Cradle to gate	Electricity	1996-12-01	S
388	OECD Europe, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
389	OECD North America, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
390	OECD Pacific, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
391	OECD total, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
392	Oil condensing power plant with support systems	Cradle to gate	Electricity	1996-12-01	S

393	Oil electricity energy system, EPD-version	Cradle to grave	Electricity	1996-10	S
394	Oil electricity energy system, ETH - full version	Cradle to grave	Electricity	1996-10	S
395	Oil filter combustion	Gate to grave	0.706 kg of filter	2002-12-12	A
396	Operation of 'Hot Dogs' producing facility. ESA-DBP	Gate to gate	1 year of operation of the facility	2005	S
397	Operation of large scale waste water treatment plant. ESA-DBP	Gate to grave	person·year	1997	S
398	Operation of liquid composting batch process. ESA-DBP	Gate to grave	person·year	1997	S
399	Operation of liquid composting continuous system. ESA-DBP	Gate to grave	person·year	1997	S
400	Operation of small-scale waste water treatment plant. ESA-DBP	Gate to grave	person·year	1997	S
401	Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP	Gate to grave	Treated sludge	1997	S
402	Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP	Gate to grave	Treated sludge	1997	S
403	Operation of waste water treatment plant with urine and sludge separation . ESA-DBP	Gate to grave	person·year	1997	S
404	Operation on desiccant cooling system - a technology in air conditioning. ESA-DBP	Gate to gate	1 year of operation of desiccant cooling system	2007	S
405	Operation on train bearings - train type 'Regina'. ESA-DBP	Gate to gate	2 axleboxes with bearings on a distance of 100 000km	2003	S
406	Operation on train bearings - train type 'X1'. ESA-DBP	Gate to gate	2 axleboxes with bearings on a distance of 100 000km	2003	S
407	Operation on train bearings - train type 'X10'. ESA-DBP	Gate to gate	2 axleboxes with bearings on a distance of 100 000km	2003	S
408	Operation on vapour compression cooling system - a technology in air conditioning. ESA-DBP	Gate to gate	1 year of operation of vapour compression cooling system	2007	S
409	Ore-based steel production	Cradle to gate	Steel	1996-10-01	S
410	Particleboard production	Cradle to gate	Particleboard	1997-05-01	U
411	Passenger plane, MD-82	Unit operation	Cargo	1997-11-19	S
412	Passenger plane, MD-82	Unit operation	Cargo	1997-11-19	S
413	Pea cultivation. ESA-DBP	Gate to gate	Pea	2005	S
414	Peat fired plant for heat and power production	Gate to gate	Heat	2000-07-07	S
415	PET	Cradle to gate	PET	1995	A
416	Phosphatising of cast iron rings	Gate to gate	Guide ring	02-12-31	S
417	Pickled hot rolled steel sheet	Gate to gate	Pickled steel sheet	02-12-31	A
418	Pine window production. ESA-DBP	Cradle to gate	Window	2000	A
419	Planting softwood plants	Gate to gate	Planted forest area	1994-02-24	A
420	Plasterboard production	Cradle to gate	Plasterboard	1997-05-01	U
421	Plastic waste incineration	Gate to grave	1 kg of plastic wastes	2003-03-10	S
422	Plywood production	Gate to gate	Plywood	02-12-31	S
423	Poland, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
424	Polyether-polyols - PUR precursors	Cradle to gate	Polyether - polyols	1996	A
425	Polyethylene	Cradle to gate	PE	1993	A
426	Polymerization in LDPE production process. ESA-DBP	Other	LDPE	2009	S
427	Polypropylene	Cradle to gate	PP	1993	A
428	Portugal, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A

429	Potentiometer assembly	Gate to gate	Potentiometers	2000-02-22	S
430	Preparation and anti-corrosive treatment of construction steel	Gate to gate	Blasted and painted construction steel	1997-03-01	A
431	Pre-stressing wire production	Gate to gate	Prestressing wire	1996-10-01	A
432	Pre-treatment of biowaste	Gate to gate	biowaste to biogasification biowaste to composting	2002-08-14	S
433	Primary aluminium production	Cradle to gate	Aluminium ingot	2002-05-07	S
434	Printed board assembly	Gate to gate	Printed boards	2000-03-07	S
435	Printing works	Gate to gate	Printed paper	1997-03-01	A
436	Processing of waste-oil into fuel oil	Gate to gate	Converted fuel oil	1998-04-17	S
437	Production and assemblage of parts to the engineering industry	Gate to gate	1996	1996-03-01	U
438	Production and refining of metal components	Gate to gate	Components of steel	1997-03-01	U
439	Production of 0,005-0,02 mm double-rolled aluminium foil	Gate to gate	Aluminium foil (0,005-0,02 mm)	2002-05-06	S
440	Production of 0,02-0,2 mm single-rolled aluminium foil	Gate to gate	Aluminium foil (0,02-0,2 mm)	2002-05-07	S
441	Production of a Corrugated Board Box (182*62*182)	Gate to gate	Corrugated Board Box	2000-01-18	S
442	Production of Alkyl Polyglucosides (APG) from coconut oil	Cradle to gate	Alcyl Polyglucosides	95-01-01	A
443	Production of ammonia	Gate to gate	Ammonia	99-01-25	A
444	Production of ammonium nitrate	Gate to gate	Ammonium nitrate	1999-01-25	A
445	Production of bearing rings	Cradle to gate	Bearing rings	02-12-31	S
446	Production of bearing rollers (à 9,2 kg)	Cradle to gate	bearing roller	02-12-31	A
447	Production of Bearing Steel	Cradle to gate	Steel ingot	2000-01-17	S
448	Production of beef. ESA-DBP	Gate to gate	Beef	2005	S
449	Production of benzene (APME)	Cradle to gate	Benzene	1999	S
450	Production of Blister Copper	Cradle to gate	Blister copper	1998	A
451	Production of brass cages used for spherical roller bearings	Gate to gate	Brass cage	02-12-31	S
452	Production of butadiene	Cradle to gate	1 kg butadiene	1999-01-01	S
453	Production of cameras, magazines and accessories	Gate to gate	Camera	1996-03-01	A
454	Production of CAN fertiliser	Gate to gate	Nitrogen fertiliser	1999-01-25	A
455	Production of CAN fertiliser AGGR	Cradle to gate	Nitrogen fertiliser	1999	A
456	Production of clean bearing steel	Gate to gate	Ingot Mould	02-12-31	S
457	Production of cooling fluid, R134a	Cradle to gate	R134a	1995	A
458	Production of Copper Anodes	Cradle to gate	Copper Anode	1998	A
459	Production of copypaper. ESA-DBP	Other	Copypaper	1997	S
460	Production of dimethylether from energy forest	Gate to gate	Dimethylethyl	1996	A
461	Production of Dowel Adhesive PVAC 3370	Cradle to gate	PVAc 3370	2000-03-06	A
462	Production of energy forest	Gate to gate	Willow	1997	A
463	Production of EPDM	Cradle to gate	EPDM	2001-03-01	A
464	Production of ethyl alcohol using energy forest and the CASH-method	Gate to gate	Ethanol Lignin	1996	A
465	Production of ethyl alcohol using energy forest and the CHAP-method	Gate to gate	Ethanol	1997	A
466	Production of ethyl alcohol using energy forest and the enzyme-method	Gate to gate	Ethanol Lignin	1996	A
467	Production of extruded aluminium profiles	Gate to gate	Extruded aluminium profile	2002-05-07	S
468	Production of guide rings used for spherical roller bearings	Cradle to gate	Guide ring	02-12-31	S

469	Production of Hardener 2542 for melamine urea formaldehyde resins 1241 and 1242 production	Cradle to gate	Hardener 2542	2003-03-26	A
470	Production of Hardener 2545 for urea formaldehyde resins	Cradle to gate	Hardener 2545	2000-03-10	A
471	Production of Hardener 2580 for urea formaldehyde resins	Cradle to gate	Hardener 2580	2000-03-10	A
472	Production of high-density polyethylene	Gate to gate	HDPE	1991	U
473	Production of hot mix for asphalt pavement.	Cradle to gate	Hot mix	2001-02-09	S
474	Production of hot rolled steel rings	Gate to gate	Hot rolled steel rings	02-12-31	S
475	Production of hydrogen (cracker) (APME)	Cradle to gate	Hydrogen (cracker)	1999	S
476	Production of injection moulding	Gate to gate	Injection moulding	1991	U
477	Production of insulation glass wool	Gate to gate	Glass wool	2002-03-03	S
478	Production of insulation rock wool	Gate to gate	Rock wool	2000-04-01	S
479	Production of iron oxide	Cradle to gate	Iron oxide	1993	U
480	Production of iron oxide yellow colorant containing Bermodol SPS 2532	Cradle to gate	Iron oxide yellow colorant containing Be	2004-04-01	A
481	Production of iron oxide yellow colorant containing Berol 09	Cradle to gate	Iron oxide yellow colorant containing Be	2004-04-01	A
482	Production of Iron Powder	Cradle to gate	Steel powder	2000-01-24	A
483	Production of Kraftliner	Gate to gate	Kraftliner	2000-01-18	S
484	Production of latex rubber	Cradle to gate	Latex rubber	1994-02-01	A
485	Production of Linear Alkylbenzene Sulphonates (LAS)	Cradle to gate	Linear Alkylbenzene Sulphonates	1995-04-01	A
486	Production of linoleum	Gate to gate	Linoleum	1994	U
487	Production of linseed oil	Cradle to gate	Linseed oil Linseed cake	1994	U
488	Production of linseed oil in Sweden	Cradle to gate	Linseed oil Linseed cake	1994	U
489	Production of low-density polyethylene	Gate to gate	LDPE	1991	U
490	Production of lubricating oil	Gate to gate	Lubricating oil	1997-03-01	A
491	Production of mastic	Gate to gate	Lime Mastic	2000-11-15	A
492	Production of matte copper	Cradle to gate	Matte copper	1998	A
493	Production of Melamin-Urea-Formaldehyde resin 1241(MUF 1241), Wood Adhesive	Cradle to gate	MUF 1241	2003-03-21	A
494	Production of Melamin-Urea-Formaldehyde resin 1242(MUF 1242), Wood Adhesive	Cradle to gate	MUF 1242	2003-03-26	A
495	Production of methanol using energy forest	Gate to gate	Methanol	1996	A
496	Production of methylene diphenyl diisocyanate, MDI (APME)	Cradle to gate	MDI (methylene diphenyl diisocyanate)	1999	S
497	Production of mounting fluid	Gate to gate	SKF LHMF 300	2002-12-12	A
498	Production of nitric acid	Gate to gate	Nitric acid	1999-01-25	A
499	Production of nitric acid (Landskrona)	Gate to gate	Nitric acid	1999-01-25	A
500	Production of nonylphenol and dinonylphenol	Gate to gate	Nonylphenol/Dinonylphenol	1997-03-01	A
501	Production of NP 27-5 fertiliser	Gate to gate	NPK fertiliser	1999-01-25	A
502	Production of NP 27-5 fertiliser AGGR	Cradle to gate	NPK fertiliser	1999	A
503	Production of NPK 20-3-5 fertiliser	Gate to gate	NPK fertiliser	1999-01-25	A
504	Production of NPK 20-3-5 fertiliser AGGR	Cradle to gate	NPK fertiliser	1999	A
505	Production of nylon 66 (APME)	Cradle to gate	PA 66	1999	S
506	Production of orthoxylene. ESA-DBP	Gate to gate	Orthoxylene	1997	A
507	Production of paint and anti corrosion agents	Gate to gate	m3	1996-03-01	A

508	Production of paint, thinner and enamel mainly for surface treatment of steel	Gate to gate	Paint/Enamel/Thinner	1997-03-01	U
509	Production of PE-film	Gate to gate	Film	1991	A
510	Production of pentane (APME)	Cradle to gate	Pentane	1999	S
511	Production of petrochemical Alcohol Ethoxylates (AE) with 3 moles of ethylene oxide (EO)	Cradle to gate	Alcohol ethoxylate (3 EO)	1995-01-01	A
512	Production of petrochemical Alcohol Ethoxylates (AE) with 7 moles of ethylene oxide (EO)	Cradle to gate	Alcohol ethoxylate (7 EO)	1995-01-01	A
513	Production of petrochemical Alcohol Sulphates (AS)	Cradle to gate	1000 kg.	1995-04-01	A
514	Production of phosphoric acid	Gate to gate	Phosphoric acid	1999-01-25	A
515	Production of phosphoric acid (48 % P2O5)	Gate to gate	Phosphoric acid	1999-01-25	A
516	Production of pig iron	Gate to gate	Pig iron	02-12-31	A
517	Production of pig iron - blast furnace process. ESA-DBP	Gate to gate	Pig iron	1996	S
518	Production of plastic strips and film	Gate to gate	ton	1996-03-01	A
519	Production of plywood boxes	Cradle to gate	plywood box	02-12-31	S
520	Production of polyamid 66 containing 30% glass fibre (APME)	Cradle to gate	PA 66 + 30%GF	1999	S
521	Production of polybutadiene (APME)	Cradle to gate	Polybutadiene	1999	S
522	Production of polyethylene resin (HDPE), (APME)	Cradle to gate	HDPE	1999	S
523	Production of polyethylene terephthalate (APME)	Cradle to gate	PET, amorphous	1999	S
524	Production of polymethyl methacrylate (APME)	Cradle to gate	PMMA beads	1999	S
525	Production of polyols (APME)	Cradle to gate	Polyols	1999	S
526	Production of polypropylene (APME)	Cradle to gate	PP	1999	S
527	Production of polystyrene (APME)	Cradle to gate	PS	1999	S
528	Production of polyvinyl chloride, emulsion polymerised (APME)	Cradle to gate	PVC (e)	1999	S
529	Production of polyvinyl chloride, suspension polymerised (APME)	Cradle to gate	PVC (s)	1999	S
530	Production of pork. ESA-DBP	Gate to gate	Pork	2005	S
531	Production of powdered limestone	Cradle to gate	Powdered limestone	1994	U
532	Production of powdered wood	Cradle to gate	Powdered wood	1994	U
533	Production of primary copper	Cradle to gate	Copper	1998	A
534	Production of PVC	Gate to gate	PVC NaOH Hydrochloric acid Dichlore ethane	1996-03-01	U
535	Production of PVC calendered sheet (APME)	Cradle to gate	PVC calendered sheet	1999	S
536	Production of PVC injection moulding (APME)	Cradle to gate	Injection moulded PVC	1999	S
537	Production of PVC pipe (APME)	Cradle to gate	PVC pipe	1999	S
538	Production of PVC unplasticised film APME	Cradle to gate	PVC unplasticised film	1999	S
539	Production of quartz sand	Gate to gate	Sand	02-12-31	A
540	Production of rolled aluminium sheet	Gate to gate	Rolled aluminium sheet	2002-05-07	S
541	Production of self-adhesive labels etc used in the manufacturing, food and pharmaceutical industry	Gate to gate	1996	1997-03-01	U
542	Production of Semichemical Fluting	Gate to gate	Semichemical Fluting	2000-01-18	S
543	Production of SKF Spherical Roller Bearing 232/530	Cradle to gate	Packed bearing	02-12-31	S

544	Production of Soap from palm oil/palm kernel oil	Cradle to gate	Soap	92-04-01	S
545	Production of sodium sulphate	Gate to gate	Sodium sulphate	1991-01-01	U
546	Production of Solvey soda	Gate to gate	Solvay soda	1991-01-01	U
547	Production of styrene (APME)	Cradle to gate	Styrene	1999	S
548	Production of sulphuric acid by roasting of pyrite	Gate to gate	H2SO4	99-01-25	A
549	Production of titanium dioxid	Cradle to gate	Titanium dioxide	1993	U
550	Production of toluene diisocyanate (APME)	Cradle to gate	TDI (toluene diisocyanat	1999	S
551	Production of TSP fertiliser	Gate to gate	Phosphorous fertiliser	1999-01-25	A
552	Production of TSP fertiliser AGGR	Cradle to gate	Phosphorous fertiliser	1999	A
553	Production of turned brass cylinders, 205 kg	Gate to gate	Brass cylinder	2002	A
554	Production of Urea-formaldehyde resin 1202 (UF 1202), Wood Adhesive	Cradle to gate	UF 1202	2000-03-07	A
555	Production of Urea-formaldehyde resin 1205 (UF 1205), Wood Adhesive	Cradle to gate	UF 1205	2000-03-07	A
556	Production of Urea-formaldehyde resin 1206 (UF 1206), Wood Adhesive	Cradle to gate	UF 1206	2000-03-07	A
557	Production of Urea-formaldehyde resin 1274 (UF 1274), Wood Adhesive	Cradle to gate	UF 1274	2000-03-07	A
558	Production of washing soda	Gate to gate	Soda	1991-01-01	U
559	Production of Wetfix I (adhesion promoter used in hot mix for asphalt pavement)	Cradle to gate	Wetfix I	2001-02-13	S
560	Production of Wine Ethanol Fuel (ETAMAX D), excluding grape cultiv. and wine prod.	Cradle to gate	ETAMAX D	1999-01-20	S
561	Production of Wine Ethanol Fuel (ETAMAX D), including grape cultiv. and wine prod.	Cradle to gate	ETAMAX D	1999-01-20	S
562	Production of wood	Gate to gate	Wood	02-12-31	S
563	Production of wood Adhesive PVAC 3316	Cradle to gate	PVAc 3316	2000-02-24	A
564	Production of wood Adhesive PVAC 3318	Cradle to gate	PVAc 3318	2000-02-14	A
565	Production of wood Adhesive PVAC 3326	Cradle to gate	PVAc 3326	2000-02-14	A
566	Propane fired combination plant for heat and power production	Gate to gate	Heat	1999-08-30	S
567	Propane fired plant for heat production - Large plant	Gate to gate	Heat	1999-08-30	S
568	Propane fired plant for heat production - Small plant	Gate to gate	Heat	1999-08-30	S
569	Pulverized wood fired plant for heat and power production - Large plant	Gate to gate	Heat	1999-08-30	S
570	Pulverized wood fired plant for heat production - Small plant	Gate to gate	Heat	1999-08-30	S
571	PVC	Cradle to gate	PVC	1994	A
572	Rail transport - 10 trucks	Unit operation	Cargo	1993-01-01	S
573	Rail transport - 10 trucks	Unit operation	Cargo	1993-01-01	S
574	Rail transport - 52 trucks	Unit operation	Cargo	1993-01-01	S
575	Rail transport - 52 trucks	Unit operation	Cargo	1993-01-01	S
576	Rape seed cultivation. ESA-DBP	Cradle to gate	Rape seed field	2005	A
577	Rapeseed lubricant	Cradle to grave	CH4 Lubricating Oil	2002-12-12	S
578	Rapeseed methyl ester (RME), cradle-to-gate, energy allocation - f3 fuels	Cradle to gate	Rapeseed methyl ester (RME)	2013-11-30	A

579	Rapeseed methyl ester (RME), cradle-to-gate, system expansion, impact categories only - f3 fuels	Cradle to gate	Rapeseed methyl ester (RME)	2013-11-30	A
580	Reconditioning of bearing	Gate to gate	1.2 kg of bearing	2002-12-18	A
581	Recycling and temporary storage of metals	Gate to gate	ton	1995-03-01	U
582	Recycling of polyethene	Gate to gate	Polyethylene	1991	U
583	Red brass sandcasting	Gate to gate	1 kg cast red brass	1995	U
584	Refinery in crude oil based LDPE production process. ESA-DBP	Other	Naphtha	2009	S
585	Refining of crude oil	Gate to gate	Refined oil products	1991	U
586	Refining of crude oil in to diesel	Gate to gate	Diesel	1996	A
587	Refining of crude oil in to petrol	Gate to gate	Petrol	1996	A
588	Reinforcement bar production	Gate to gate	Reinforcement bar	1997-05-01	A
589	Relay assembly	Gate to gate	Relays	2000-03-09	S
590	Remelting of aluminium scrap	Gate to gate	Aluminium ingot	2002-05-07	S
591	Resistor for hole mounting assembly	Gate to gate	Resistor for hole mounting	2000-02-18	S
592	Resistor for surface mounting assembly.	Gate to gate	Resistor for surface mounting	2000-02-24	S
593	Resistor network assembly	Gate to gate	Resistor networks	2000-03-15	S
594	Retapping of cooling medium in tanks	Gate to gate	CFC HCFC HFC	1997-03-01	A
595	Rigid PUR foam	Gate to gate	Rigid	1996	A
596	Ring processes at SKFs site in Göteborg	Gate to gate	Bearing rings	02-12-31	A
597	RME combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
598	RME combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels	Gate to grave	1 MJ	2013-11-30	A
599	Roll-on-roll-off vessel (RoRo)	Gate to gate	Cargo	1998 08	S
600	RoRo vessel, 2000-30000 dwt	Unit operation	Cargo	1997-11-19	S
601	RoRo vessel, 2000-30000 dwt, future	Unit operation	Cargo	1997-11-19	S
602	Sand extraction and processing. ESA-DBP	Gate to gate	Sand	1996	S
603	Sausage (Hot-Dog) production. ESA-DBP	Gate to gate	Sausage Hot - Dog	2005	S
604	Sausage (Pea-Dog) production. ESA-DBP	Gate to gate	Sausage Pea - Dog	2005	S
605	Sausage (Soy-Dog) production. ESA-DBP	Gate to gate	Sausage Soy - Dog	2005	S
606	Sawed construction timber production	Cradle to gate	Sawed timber	1996-04-02	A
607	Scalable electric traction motor, permanent magnet (PMSM), for EVs	Gate to gate	Electric traction motor, permanent magnet (PMSM), for EVs	2016-07-01	A
608	Scalable inverter unit, electric motor controller, IGBT transistors, for EVs	Gate to gate	Inverter unit, electric motor controller, IGBT transistors, for EVs	2018-10-02	
609	Scrap-based aluminium production	Cradle to gate	Aluminium	1996-05-01	A
610	Scrap-based steel production	Gate to gate	Steel	1996-10-01	A
611	Scrap-based steel production	Gate to gate	Steel	1996-05-01	A
612	Seatbelt assembly. Autoliv ESA-DBP	Unit operation	Seatbelt	2010-07-08	S
613	Seatbelt's bobbin manufacturing. Autoliv ESA-DBP	Gate to gate	Bobbin	2010-07-08	S
614	Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP	Gate to gate	Car sense ball	2010-07-08	S
615	Seatbelt's frame production. Autoliv ESA-DBP	Gate to gate	Metal frame	2010-07-08	S
616	Seatbelt's gas generator assembly. Autoliv ESA-DBP	Unit operation	Gas generator	2010-07-08	S
617	Seatbelt's header manufacturing. Autoliv ESA-DBP	Gate to gate	Header	2010-07-08	S
618	Seatbelt's initiator, serviceable assembly. Autoliv ESA-DBP	Unit operation	Initiator serviceable	2010-07-08	S

619	Seatbelt's label bam manufacturing. Autoliv ESA-DBP	Gate to gate	Label bam	2010-07-08	S
620	Seatbelt's pillar loop production. Autoliv ESA-DBP	Gate to gate	Pillar loop	2010-07-08	S
621	Seatbelt's polyamide granules production. Autoliv ESA-DBP	Unit operation	Polyamide granules	2010-07-08	S
622	Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP	Unit operation	Pretensioner retractor	2010-07-08	S
623	Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP	Gate to gate	Rivet nut	2010-07-08	S
624	Seatbelt's short tube assembly. Autoliv ESA-DBP	Unit operation	Short tube	2010-07-08	S
625	Seatbelt's solder paste manufacturing. Autoliv ESA-DBP	Gate to gate	Solder paste 1	2010-07-08	S
626	Seatbelt's spindle assembly. Autoliv ESA-DBP	Unit operation	Spindle	2010-07-08	S
627	Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP	Gate to gate	Spring antiretour	2010-07-08	S
628	Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP	Gate to gate	Spring, wire	2010-07-08	S
629	Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP	Gate to gate	Synchronization ball	2010-07-08	S
630	Seatbelt's tongue production. Autoliv ESA-DBP	Gate to gate	Tongue	2010-07-08	S
631	Seatbelt's tube manufacturing. Autoliv ESA-DBP	Gate to gate	Tube	2010-07-08	S
632	Seatbelt's web sensor manufacturing. Autoliv ESA-DBP	Gate to gate	Web sensor	2010-07-08	S
633	Seatbelt's webbing manufacturing. Autoliv ESA-DBP	Gate to gate	Webbing	2010-07-08	S
634	Si wafer production and Si wafer processing for integrated circuits	Gate to gate	Silicon wafer	2000-03-03	S
635	Si wafer production and Si wafer processing for transistors	Gate to gate	Silicon wafer	2000-03-07	S
636	Silviculture of softwood AGGR	Cradle to gate	Forest land Softwood at roadside	1999	A
637	Sinter plant's process ESA-DBP	Gate to gate	Sinter	1996	S
638	Slow speed, two-stroke diesel vessel engine	Unit operation	Mechanical work	1991-01-01	A
639	Slow speed, two-stroke diesel vessel engine	Unit operation	Mechanical work	1991-01-01	A
640	Smelt iron in a ladle	Unit operation	Iron	02-12-31	S
641	Smelt iron in a teaming ladle before casting	Unit operation	Iron	02-12-31	A
642	Smelting of iron, type V10	Unit operation	Iron	02-12-31	S
643	Soil preparation	Gate to gate	Cultivated forest area	1994-02-24	A
644	Solid waste management AGGR	Gate to grave	Compost Electricity	2002	S
645	Solid wood flooring. ESA-DBP	Cradle to grave	Solid wood flooring	1994	S
646	Sorting of solid municipal waste	Gate to gate	Biowaste Waste to incineration Waste to landfill Waste to recycling	2002-08-14	S
647	Soy bean cultivation. ESA-DBP	Cradle to gate	Soy bean field	2005	S
648	Soy bean processing. ESA-DBP	Gate to gate	Processed soy bean	2005	S
649	Spain, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
650	Stage performance in a theatre. ESA-DBP	Gate to gate	Performance for 1 person	2010	S
651	Stage performance in an opera. ESA-DBP	Gate to gate	Performance for 1 person	2010	S
652	Steam cracking in crude oil based LDPE production process. ESA-DBP	Other	Ethylene	2009	S
653	Steam cracking of refined oil products	Gate to gate	Ethylene	1991	U
654	Steel jointing production	Other	Steel jointings	1997-05-01	U
655	Steel rail production	Gate to gate	Steel rail	1997-05-01	A

656	Steeping of gas tanks	Gate to gate	ton	1997-03-01	A
657	Stone coal electricity energy system, EPD-version	Cradle to grave	Electricity	1996-10	S
658	Stone coal electricity energy system, ETH - full version	Cradle to grave	Electricity	1996-10	S
659	Storage and distribution of chemicals and intermediate storage of hazardous waste.	Gate to gate	1996	1997-03-01	U
660	Storage of ammonia	Gate to gate	Ammonia	1999-01-25	A
661	Sugar beet cultivation. ESA-DBP	Cradle to gate	Sugar beet field	2005	A
662	Sugarcane cultivation. ESA-DBP	Cradle to gate	Sugarcane	2009	S
663	Surface Coating of bearing roller	Unit operation	roller	2002-12-12	S
664	Sweden, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
665	Swedish average electricity AGGR	Cradle to gate	Electricity	1999	S
666	Swedish electricity production system	Other	Electricity	1997-05-01	S
667	Swedish red paint manufacturing and application. ESA-DBP	Gate to gate	Swedish red paint	1999	S
668	Swedish reinforcement steel mix	Other	Steel	1996-10-01	S
669	Swedish sheet steel mix	Other	Steel	1996-10-01	S
670	Switzerland, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
671	Tankers	Unit operation	Cargo	1994-04-01	S
672	TDI - PUR precursors	Cradle to gate	TDI	1996	A
673	Thermal treatment of solid municipal waste	Gate to gate	1 tonne of waste to incineration	2002-08-14	S
674	Thinning of forest area	Gate to gate	Unspecified Thinned forest area Thinning softwood	1994-02-24	A
675	Transistor assembly	Gate to gate	Transistor capsule	2000-02-28	S
676	Transport with a compressed natural gas bus. ESA-DBP	Gate to gate	1 bus km	2002	S
677	Transport with a diesel bus. ESA-DBP	Gate to gate	1 bus km	2002	S
678	Transport with a fuel cell bus run on hydrogen produced in electrolysis process. ESA-DBP	Gate to gate	1 bus km	2002	S
679	Transport with a fuel cell bus run on hydrogen produced in steam reforming process. ESA-DBP	Gate to gate	1 bus km	2002	S
680	Transportation of crude oil to Sweden	Gate to gate	Crude oil	1996	A
681	Transportation with diesel driven waste collection vehicle. ESA-DBP	Unit operation	1 km of transportation	2005	A
682	Transportation with gas driven waste collection vehicle. ESA-DBP	Unit operation	1 km of transportation	2005	A
683	Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP	Unit operation	1 km of transportation	2005	A
684	Treatment of waste oil from industries and municipalities	Gate to gate	Treated oil	1999-04-15	S
685	Treatment of hazardous waste	Gate to grave	Electricity/Heat	1999-04-18	S
686	Treatment of hazardous waste from industries and municipalities	Gate to gate	ton	1994-03-01	A
687	Treatment of oil-contaminated waste water	Gate to gate	m3	1994-03-01	A
688	Treatment of oil-contaminated waste water	Gate to gate	Waste oil Water	1999-04-15	S
689	Treatment of sewage	Gate to gate	Thermal energy Water	1997-03-01	S
690	Tree plant nursing	Gate to gate	Tree plants	1994-02-24	A
691	Truck chassi manufacturing. ESA-DBP	Gate to gate	Chassi	2001	S
692	Truck Göteborg to SAKAB	Gate to gate	Oil-sludge	1999-04-20	A

693	Truck Halmstad to Göteborg (Scrap)	Gate to gate	Scrap	1999-04-20	A
694	Truck Halmstad to Göteborg (Water-sludge)	Gate to gate	Water-sludge	1999-04-20	A
695	Truck Halmstad to SAKAB	Gate to gate	Oil-sludge	1999-04-20	A
696	Truck Jönköping to Halmstad	Gate to gate	Waste oil	1999-04-20	A
697	Truck Reci Göteborg to Sävenäs	Gate to gate	Scrap	1999-04-20	A
698	Truck tire production. ESA-DBP	Gate to gate	Rubber tire	Unknown	S
699	Truck with semitrailer, max 42 tonnes, future	Unit operation	Cargo	1997-11-19	S
700	Truck with semitrailer, max 42 tonnes, manufactured after 1996 [Euro 2]	Unit operation	Cargo	1997-11-19	S
701	Truck with semitrailer, max 42 tonnes, manufactured before 1992 [Euro 0]	Unit operation	Cargo	1997-11-19	S
702	Truck with semitrailer, max 42 tonnes, manufactured between 1992 and 1995 [Euro1]	Unit operation	Cargo	1997-11-19	S
703	Truck, long distance transportation	Unit operation	Cargo	1994-04-01	S
704	Truck, regional distribution	Unit operation	Cargo	1994-04-01	S
705	Truck, urban distribution	Unit operation	Cargo	1994-04-01	S
706	Turkey, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
707	Turning of cast iron rings	Unit operation	Guide ring	02-12-31	S
708	Turning of steel bars into bearing rollers	Unit operation	turned roller	02-12-31	S
709	Turning of steel rings at SKFs site in Göteborg	Unit operation	turned steel rings	02-12-31	S
710	United Kingdom, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
711	United States, electricity generation mix 1998	Unit operation	Electricity	2001-01-31	A
712	Unmodified natural gas vehicle (NGV) operating on CNG with 15 % hydrogen (HCNG-15). ESA-DBP	Gate to gate	1 vehicle km	2001/2002	A
713	Unmodified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP	Gate to gate	1 vehicle km	2001/2002	A
714	Uranium ore extraction and enrichment. ESA-DBP	Gate to gate	Enriched uranium	1996	S
715	Use of bearing at a paper mill	Unit operation	Bearing	2002-12-01	A
716	Use phase of train bearings - train type 'Regina'. ESA-DBP	Gate to gate	2 axleboxes with bearings on a distance of 100 000km	2003	S
717	Use phase of train bearings - train type 'X1'. ESA-DBP	Gate to gate	2 axleboxes with bearings on a distance of 100 000km	2003	S
718	Use phase of train bearings - train type 'X10'. ESA-DBP	Gate to gate	2 axleboxes with bearings on a distance of 100 000km	2003	S
719	Wafer production, for photovoltaic cells. ESA-DBP	Cradle to gate	wafer	2006	S
720	Waste collection vehicle, diesel driven. ESA-DBP	Cradle to grave	one metric ton of collected waste	2005	S
721	Waste collection vehicle, driven by compressed natural gas. ESA-DBP	Cradle to grave	one metric ton of collected waste	2005	S
722	Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP	Cradle to grave	one metric ton of collected waste	2005	S
723	Waste disposal	Gate to gate	1996	1996-03-01	A
724	Waste disposal of building, industrial and hazardous waste	Gate to gate	ton	1997-03-01	A
725	Waste to energy plant	Gate to gate	Heat	99-08-30	S
726	Waste treatment - incineration for heat in cement kiln (SWEA CKN)	Gate to grave	1 kg waste fraction to incineration in cement kiln	2013-03-18	S
727	Waste treatment - incineration in combined heat and power plant (SWEA CHP)	Gate to grave	1 kg waste fraction to incineration in CHP plant	2013-03-18	S
728	Waste treatment - incineration in heat only boiler plant (SWEA HOB)	Gate to grave	1 kg waste fraction to incineration in HOB plant	2013-03-18	S

729	Waste treatment - landfill (SWEA LFL)	Gate to grave	1 kg waste fraction to landfill	2013-03-18	S
730	Waste treatment - reactor composting (SWEA CPR)	Gate to grave	1 kg waste fraction to reactor composting	2013-03-18	S
731	Waste treatment - windrow composting (SWEA CPW)	Gate to grave	1 kg waste fraction to windrow composting	2013-03-18	S
732	Vattenfall electricity production system	Other	Electricity	1996-12-01	S
733	Vessel Göteborg to Halmstad	Gate to gate	Waste oil	1999-04-20	A
734	Vessel Halmstad to Slite	Gate to gate	Converted fuel oil	1999-04-20	A
735	Vessel Loudden to Halmstad	Gate to gate	Waste oil	1999-04-20	A
736	Wheat cultivation. ESA-DBP	Gate to gate	Wheat	2005	S
737	Wind electricity energy system, EPD-version	Cradle to grave	Electricity	1996-10	S
738	Wind power plant with support systems	Cradle to gate	Electricity	1996-12-01	S
739	Vinyl flooring. ESA-DBP	Cradle to grave	Vinyl flooring	1994	S
740	Virgin aluminium production	Cradle to gate	Aluminium	1996-05-01	S
741	Virgin steel production	Cradle to gate	Steel	1996-05-01	S
742	Wood chips fired plant (with stoker) for heat and power production - Large plant	Gate to gate	Heat	1999-08-30	S
743	Wood chips fired plant (with stoker) for heat production - Small plant	Gate to gate	Heat	1999-08-30	S
744	Wood fired CFB plant for heat and power production - Large plant	Gate to gate	Heat	1999-08-30	S
745	Wood fired CFB plant for heat production - Small plant	Gate to gate	Heat	1999-08-30	S
746	Wood pellets fired plant for heat and power production - Large plant	Gate to gate	Heat	1999-08-30	S
747	Wood pellets fired plant for heat production - Small plant	Gate to gate	Heat	1999-08-30	S
748	Wool/polyamide covering of sofa. ESA-DBP	Cradle to grave	''The functional unit was: surface covering of a 3-seat sofa for private use during 10 years.'' For wool/PA fabric it is 5.27 kg per sofa.	2004	S

Table 2. Complete life cycle inventory datasets in the CPM LCA Database as of 2020-11-20. In alphabetical order.

SPINE LCI dataset: ''Other'' electronic components assembly

Administrative	
Finished	Y
Date Completed	2000-03-15
Copyright	Ericsson
Availability	Official

Technical System	
Name	''Other'' electronic components assembly
Functional Unit	One gram of ''odd'' (other) electronic component
Functional Unit Explanation	The motivation for choosing this functional unit is: · Suitable unit to work with in an LCA of a private branch exchanges (a complicated telecom product) · Important component of the MD110 product system and many other electronic products. DESIGN These facts are based on Ericsson technical specification of the components. -- Component manufacturer one -- Ericsson product number: RMD 994 002/1 Ericsson description: Push-button switch. General: The push button switch is intended for keyboards and similar applications, where it is mounted on a circuit board. The switch is available in a non-locking model only. PCB thickness 1.6 mm. Design general: Material Lower housing: PA 6.6 GV (Nylon) Upper housing: PA 6.6 GV (Nylon) Contact spring: Phosphorous bronze Actuated stem: Acetal plastic Surface treatment: Contact area: 0,25e-6 m AuAg on Ni Soldering terminals: SnPb on Ni Dimensions Height: 18.5 mm, Length: 15,6 mm, Width: 15,6 mm, Terminal thickness: 2,54 mm Weight: 1,584 g (Ericsson: 2 g) -- Component manufacturer two -- Ericsson product number: RLE 113 500/1 Ericsson description: Loudspeaker. General: Loudspeaker intended for panel mounting, with plastic frame. Diameter 50 mm. Design general: Weight app. 47 g (Ericsson specification) Material Frame: Polystyrene (PS) Membrane: Polycarbonate (PC) Surface treatment: Soldering tags shall be pre-tinned Dimensions: Height: 50 mm (diameter) Length: 22.6 mm Width: 50 mm (diameter) Terminal thickness: 0.5 mm Weight: 6.8 g (acc. to CM2)
Process Type	Gate to gate

Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of an ''other'' electronic component. The activity is an average based on information acquired from two manufacturers. The model for the component is based on systems for a toggle-switch and a loudspeaker. The description of the process is supplied by both manufacturers and is assumed to be general for manufacturing of ''other'' electronics. The following process steps are included; --Component manufacturer one-- Component manufacturer one assembles loudspeakers. The following steps are included: 1. Voice coil winding 3. System moulding 2. Voice coil moulding 4. Inserting tags 5. Voice coil mounting 6. Welding 7. Glue application 8. Membrane deepdrawing 9. Inserting of membrane 10. Hardening of glue 11. Insert dustcap 12. Hardening of glue 13. Magenitzation 14. Acoustic test 15. Packing Detalis given about some steps: 1.Voice coil winding: Mechanized winding and baking of self-supporting coil 2. Voice coil moulding: The coil is covered with plastics together with the lead wires, then connection of lead wires to coil wire by spark welding. 3. System moulding: The magnet system is moulded in plastic together with forming the basket in one step 8. Membrane deepdrawing: The plastic membrane is manufactured at the line by a special thermoforming machine 6. Welding: The tags are connected to the lead wires by resistance welding 7. Glue application: Usage of UVA- hardening glues 14. Acoustic test: 100% manual testing --Component manufacturer two-- Component manufacturer two assembles toggle-switches. The following steps are included: 1. Supply of punching material 2. Punching of terminals 3. Parts supply at automates 4. Automated assy. incl. testing 5. Packaging 6. Final testing 7. Shipment Details given: - terminals are punched and the gold file is welded onto the parts within the same process - assembly and testing is done on round assembly automate; no further work procedures are required

System Boundaries

Nature Boundary	The emissions to air and ground have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impact has been studied. Included component manufacturers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used. Emissions to water are not included due to lack of data.

Time Boundary	1998 The answer from the manufacturer arrived in 1998 and they measured in 1998. The process technology used is most certainly the best available as the factories are located in western Germany and Austria and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturers included in the average are located in Germany and Austria.
Other Boundaries	Delimitation's to the system is the final step in the making of the ''odd'' electronic component. The model for the component is based on systems for a toggle-switch and a loudspeaker. The production of the subparts (e.g. for the switch socket, cover, actuator and springs) of the switch is not included in this model. The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	
Method	The calculation for all flows is done like this: First the amount of each flow per functional unit is calculated then each unique flow is summed and divided by the number of answers. This gives the average values for each flow. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+..+.ACn Step 2: The sum AC11+..+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to three answers was made.
Literature Reference	Two answers from one loudspeaker manufacturer and one push-button switch manufacturer manufacturers make up this LCI model.
Notes	None

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: (340 mg + 228 mg) / 1584 mg = 0.358 g/g (In contact bracket and moving blade respectively) CM2: 300 mg/6854,8 mg = 0.044 g/g (CM1+CM2)/2 = 0.201 g brass/g other electronic component This is an average value based on two answers.	Input	Refined resource	Brass	0.201			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 3.5 mg/6854.8 mg = 0.00051 g/g (Packaging material used by CM2) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Cardboard	0.00051			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0.75 mg/6854.8 mg = 0.0001094 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Cd	0.0001094			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 170 mg/6854.8 mg = 0.024 g/g (In ceramic magnet) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Ceramic	0.024			g	Technosphere	

Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 155mg /6854.8 mg = 0.023 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Copper	0.023			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1 mg/ 1584 mg = 0.00063 g/g (In wire as Ni, AuAg alloyed) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Cu alloy	0.00063			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states a use of 10 mg ink for one loudspeaker (''other'' component) which weighs 6,8548 grams. Hence, 10e-3/6,8548 = 1,46e-3 g /g other This is not an average value and the figure is based only on one answer.	Input	Refined resource	Dyes	0.00146			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an electricty consumption of 71 Wh for one loudspeaker (''other'' component) which weighs 6,8548 grams. Hence, 71/6,8548 = 10,357 Wh /g other Switch manufacturer, CM1, states an electricty consumption of 15,2 kJ for one switch (''other'' component) which weighs 1,584 grams. 1 Wh = 3,6 kJ Hence, 15,2/(3,6*1,584) = 2,665 Wh /g other Average value: (10,357 Wh /g other + 2,665 Wh /g other)/2 = 6,51 Wh/g This is an average value and the figure is based on two answers.	Input	Refined resource	Electricity	6.51			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 100 mg/6854.8 mg = 0.0146 g/g (UV-Glue) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Glue	0.0146			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Switch manufacturer, CM1, states a use of hydrogen of 0,00002 mg for one switch (''other'' component) which weighs 1,585 grams. Hence, 0,00002e-3/1,585 = 1,26e-8 g/g other This is not an average value and the figure is based only on one answer.	Input	Refined resource	Hydrogen	1.26E-08			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.0032 mg/ 1584 mg = 2.02e-6 g/g (Oil, punching) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Oil	2.02E-06			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Switch manufacturer, CM1, states a use of solvent of 0,0004 mg for one switch (''other'' component) which weighs 1,585 grams. Hence, 0,0004e-3/1,585 = 2,52e-7 g/g other This is not an average value and the figure is based only on one answer.	Input	Refined resource	Oxygen	2.52E-07			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 1200 mg/6854.8 mg = 0.175 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	PC	0.175			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 15 mg/6854.8 mg = 0.00218 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Poly(butylene terephthalate)	0.00218			g	Technosphere	

	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 260 mg / 1584 mg = 0.164 g/g (In actuator) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polyacetal	0.164			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: (687 mg + 374 mg) / 1584 mg = 0.669 g/g (In socket and cover respectively) CM2: 170 mg/6854,8 mg = 0.024 g/g (CM1+CM2)/2 = 0.347 g PA/g other electronic component This is an average value based on two answers.	Input	Refined resource	Polyamides	0.347			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 6500 mg/6854.8 mg = 0.948 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polystyrene	0.948			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 1 mg/6854.8 mg = 0.000146 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Sn/Pb plating	0.000146			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: Switch manufacturer, CM1, states a use of solvent of 0,04 mg for one switch (''other'' component) which weighs 1,585 grams. Hence, 0,04e-3/1,585 = 2,52e-5 g/g other This is not an average value and the figure is based only on one answer.	Input	Refined resource	Solvent	0.0000252			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 64 mg / 1584 mg = 0.04 g/g (In spring as CrNi steel) CM2: 220 mg/6854,8 mg = 0.032 g/g (CM1+CM2)/2 = 0.036 g stainless steel/g other electronic component This is an average value based on two answers.	Input	Refined resource	Stainless steel	0.036			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an emission to soil of 3 mg brass for one loudspeaker (''other'' component) which weighs 6,8548 grams. Hence, 3e-3/6,8548 = 4,38e-4 g brass/g other This is not an average value and the figure is based only on one answer. Literature: Answer from one manufacturer	Output	Emission	Brass	0.000438			g	Ground	
	Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an emission to soil of 0,003 mg cadmium for one loudspeaker (''other'' component) which weighs 6,8548 grams. Hence, 3e-6/6,8548 = 4,38e-7 g /g other This is not an average value and the figure is based only on one answer.	Output	Emission	Cd	4.38E-07			g	Ground	
	Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an emission to soil of 1,7 mg ceramic magnet for one loudspeaker (''other'' component) which weighs 6,8548 grams. Hence, 1,7e-3/6,8548 = 2,48e-4 g/g other This is not an average value and the figure is based only on one answer.	Output	Emission	Ceramic	0.00025			g	Ground	
	Date concieved: 1998 Data type: Derived, unspecified Method: Switch manufacturer, CM1, states an emission to air of 0,003 mg for one switch (''other'' component)	Output	Emission	CO	1.89E-06			g	Air	

which weighs 1,585 grams. Hence, 3e-6/1,585 = 1,89e-6 g/g other This is not an average value and the figure is based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an emission to soil of 1,45 mg copper for one loudspeaker (’’other’’ component) which weighs 6,8548 grams. Hence, 1,45e-3/6,8548 = 2,12e-4 g brass/g other This is not an average value and the figure is based only on one answer.	Output	Emission	Cu	0.000212			g	Ground	
Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an emission to soil of 1,00 mg acrylatic glue for one loudspeaker (’’other’’ component) which weighs 6,8548 grams. Hence, 1,00e-3/6,8548 = 1,46e-4 g /g other This is not an average value and the figure is based only on one answer.	Output	Emission	Glue, acrylatic	0.000146			g	Ground	
Date concieved: 1998 Data type: Derived, unspecified Method: Switch manufacturer, CM1, states an emission to air of 0,0003 mg for one switch (’’other’’ component) which weighs 1,585 grams. Hence, 1e-7/1,585 =6,31e-8 g/g other This is not an average value and the figure is based only on one answer.	Output	Emission	Ozone	6.31E-08			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an emission to soil of 3,00 mg PC for one loudspeaker (’’other’’ component) which weighs 6,8548 grams. Hence, 3,00e-3/6,8548 = 4,38e-4 g /g other This is not an average value and the figure is based only on one answer.	Output	Emission	PC	0.000438			g	Ground	
Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an emission to soil of 0,15 mg polyester for one loudspeaker (’’other’’ component) which weighs 6,8548 grams. Hence, 0,15e-3/6,8548 = 2,19e-5 g /g other This is not an average value and the figure is based only on one answer.	Output	Emission	Poly(butylene terephthalate)	0.000022			g	Ground	
Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an emission to soil of 1,00 mg PA for one loudspeaker (’’other’’ component) which weighs 6,8548 grams. Hence, 1,00e-3/6,8548 = 1,46e-4 g /g other This is not an average value and the figure is based only on one answer.	Output	Emission	Polyamides	0.000146			g	Ground	
Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer states, CM2, an emission to soil of 1,00 mg PS for one loudspeaker (’’other’’ component) which weighs 6,8548 grams. Hence, 5,5e-3/6,8548 = 8,02e-4 g /g other This is not an average value and the figure is based only on one answer.	Output	Emission	Polystyrene	0.0008			g	Ground	
Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an emission to soil of 0,01 mg tin/lead for one loudspeaker (’’other’’ component) which weighs 6,8548 grams. Hence, 0,01e-3/6,8548 = 1,46e-6 g /g other This is not an average value and the figure is based	Output	Emission	SnPb30 plating	1.46E-06			g	Ground	

only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: Loudspeaker manufacturer, CM2, states an emission to soil of 2,2 mg steel for one loudspeaker (''other'' component) which weighs 6,8548 grams. Hence, 2,2e-3/6,8548 = 3,2e-4 g /g other This is not an average value and the figure is based only on one answer.	Output	Emission	Steel	0.00032			g	Ground	
Date concieved: 1999 Data type: Derived, unspecified Method: Other electronic components = Life Cycle Inventory model for production of one gram of other components (applicable to telecommunication equipment). ''Other'' components are components that can not be fitted into these groups: 1. Display units and indicators 2. Diodes 3. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) 4. Transistors and opto couplers (2 models) 5. Connectors and holders 6. Cables 7. Relays 8. Transformers and inductors 9. Potentiometers 10. Resistors, varistors and thermistors; hole mounted devices 11. Resistors; surface mounted devices 12. Resistor networks 13. Capacitors and filters; hole mounted devices 14. Capacitors; surface mounted devices 15. Printed boards	Output	Product	Other electronic components	1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0.45 mg/6854.8 mg = 6.56e-5 g/g This is not an average value and the figure is based only on one answer. Notes: 100 % by mass is recycled. Consists of a copper alloy.	Output	Residue	Cd	0.0000656			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 10 mg /6854.8 mg = 0.00146 g/g This is not an average value and the figure is based only on one answer. Notes: 100 % by mass is recycled.	Output	Residue	Cu	0.00146			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 369 mg/ 1584 mg = 0.232 g/g This is not an average value and the figure is based only on one answer. Notes: 100 % by mass is recycled	Output	Residue	Metals	0.232			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.0013 mg/ 1584 mg = 8.2e-7 g/g (Oil, hydraulic) This is not an average value and the figure is based only on one answer. Notes: 77 % by mass is recycled.	Output	Residue	Oil	8.2E-07			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 900 mg/6854.8 mg = 0.131 g/g This is not an average value and the figure is based only on one answer. Notes: PC-film	Output	Residue	PC	0.131			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 70 mg/6854.8 mg = 0.01 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Polyamides	0.01			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 1000 mg/6854.8 mg = 0.146 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Polystyrene	0.146			g	Technosphere	

Notes: 100 % by mass is recycled.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.04 mg/ 1584 mg = 2.52e-5 g/g This is not an average value and the figure is based only on one answer. Notes: 90 % by mass is recycled	Output	Residue	Solvent	0.0000252			g	Technosphere	

About Inventory

Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map an ''other'' electronic component process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of ''other'' electronics and resembling components in our telecom products. Examples of odd electronic components are microphones, loudspeakers, batteries, antennas, switches, floopy disks, footpedals, headsets, fuses and circuit breakers. The usage for this set of data is life cycle assessments where ''odd'' electronics are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly

	6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to ''other'' electronic components in electronic equipment if you know how much the components weigh. See Functional Unit Explanation for a description of what is included in ''other'' electronic component. Generally, ''Other'' components are components that can not be fitted into these groups: 1. Display units and indicators 2. Diodes 3. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) 4. Transistors and opto couplers (2 models) 5. Connectors and holders 6. Cables 7. Relays 8. Transformers and inductors 9. Potentiometers 10. Resistors, varistors and thermistors; hole mounted devices 11. Resistors; surface mounted devices 12. Resistor networks 13. Capacitors and filters; hole mounted devices 14. Capacitors; surface mounted devices 15. Printed boards Examples of other electronic components are microphones, loudspeakers, batteries, antennas, switches, floopy disks, footpedals, headsets, fuses and circuit breakers. -- Transports. -- Here follows a more detailed description of transports of materials and components to the respective manufacturer factories. These transports are not included in the model. CM1 = Component manufacturer one The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport. -- Truck transportation: -- Component manufacturer one (CM1): Weight of component: 1.584 g Socket with weight 0.687g is transported 90 km by truck, i.e. 0.687 g * 90 km Cover 0.374*110, Actuator 0.260*110 and Spring 0.064*280 The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 149,49 gkm /1,584 g = 94,375 gkm /g other

	Component manufacturer two (CM2): Weight of component: 6.8548 g Steel 0.22 g * 1200 km Ceramic (Magnet) 0.17*1200 km Polystyrene 7*800, Polyamide 0.17*20, PC-film 1.2*1000 Brass (tag) 0.3*1100 UV-Glue 0.1*500 Cardboard (packing) 0.0035*15 Ink 0.01*20 Coil wire 0.15*200 Lead wire 0.005*20 This gives: 7680.3525 gkm /6,8548 g = 1120.43 gkm /g other This gives the average total transportation work by truck for CM1 and CM2: (CM1+CM2)/2 = 607.41 gkm/g -- Airplane transportation: -- Component manufacturer two (CM2): Weight of component: 6.8548 g Mylar (cap) 0.015*10000 km Mylar is a polyester plastic material. This gives: 150 gkm/6.8548 g = 21.88 gkm/g other -- Boat transportation: -- Component manufacturer two (CM2): Weight of component: 6.8548 g Steel 0.22 g * 10000 km Ceramic (Magnet) 0.17*10000 km This gives: 3900 gkm/6.8548 g = 568.94 gkm/g other
About Data	The data is based on information from one German and one Austrian manufacturer. The information was gathered using a life cycle inventory questionnaire. All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model. Of the flows about little more than 90 % are not average values. The flows for Energy input of Electricity, Raw material input of Brass, PA and Stainless Steel are average values. In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included. The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. The result is that approximately 57 % of the flows used in all manufacturers answers were only calculated, 7 % were only estimated, 36 % were only measured. The outline of the LCI data questionnaire that was used in the inventory follows below. No limitations or specifications were set for which substances they had to account -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes. Process description.

	Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gathered it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (E.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount (mg). Amount In Product (mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production sites (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Air-and-water air conditioning system. ESA-DBP

Administrative	
Finished	Y
Date Completed	2007
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Air-and-water air conditioning system. ESA-DBP
Functional Unit	Treatment and the distribution of totally 34 m3/s airflow for 17000 m2 landscape office area, when the cooling loads are totally 1189 MWh/year.
Functional Unit Explanation	For the whole building, four air-handling units of similar size are designed for the offices, and two smaller air handling units for the technical equipment and services. The data are valid for 1 year.
Process Type	Cradle to gate
Site	Unknown
Sector	Goods and services for households
Owner	Unknown

Technical system description	Schematics of the system can be found in the reference report (see 'Publication'). Excerpt from the report, see 'Publication': ''In the late 1980s, usage of air-and-water systems became as common as that of all-air systems. These systems may demand more materials owing to the distribution systems for two cooling agents: air and water. (...) Besides the air handling unit and chiller, the distribution systems for air, i.e. air ducts etc., and water, i.e. pipes and supply air beams etc., are also included. (...) The six storeyed building, with an office area of 17000m2, is situated in the south-west of Sweden, in Gothenburg. Besides offices, the building contains also conference area, canteen and the place for the technical equipment. For the LCA study, however all storeys are assumed to be similar. A storey (ca 2850 m2) consists of an office landscape area that is divided into work places (each of 12 m2). The internal loads during the workday (8.00-17.00) are estimated to 37 W/m2, comprising 15 W/m2 for lighting, 13 W/m2 for computerised equipment, and 9 W/m2 for occupants. The air temperature in offices during the summer varies between 23.5-25-5 °C. (...) The function of the AC system is to assure that the requirements for the thermal comfort in offices will be achieved. (...) For the whole building, four air-handling units of similar size are designed for the offices, and two smaller air-handling units for the technical equipment and services. (...) To achieve the predicted thermal climate in offices, the AC system is supplying an airflow of 2.3 l/s.m2 at 17° C. The airflow is distributed partly by SATD, and party by SAB, which are additionally cooled by water at 7°C.'' Main assumptions made for this study are (NB: based on the comparative table): air-and-water; vapour compression technique of cooling; constant airflow, reduced during the night; air-conditioning system; life cycle phases: production, user; office area: 17000 m2; total airflow: 34m3/s; supply air temperature: 17°C, exhaust air temperature 25°C; internal heat loads 37 W/m3; cooling loads: 1189 MWh/year; operating time: 8760 h/year, SFP: 2.5 kW/(m3/s), life span: 15 years. This process is included in the system described in: Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007 Other processes in the CPM Database also included in the above publication: - Bore-hole based air-conditioning system. ESA-DBP - Air-conditioning system. ESA-DBP - All-air air handling unit with a cooling coil and vapour compression chiller with a refrigerant. ESA-DBP - All-air desiccant cooling air handling unit. ESA-DBP - Operation on desiccant cooling system - a technology in air conditioning. ESA-DBP - Operation on vapour compression cooling system - a technology in air conditioning. ESA-DBP

System Boundaries

Nature Boundary	In the study production of the materials and the use phase are considered. The inventory analysis included parameters describing resource use and emissions to air and water.
Time Boundary	2001
Geographical Boundary	Göteborg, Sweden
Other Boundaries	Main assumptions made for this study are (NB: based on the comparative table): air-and-water; vapour compression technique of cooling; constant airflow, reduced during the night; air-conditioning system; life cycle phases: production, user; office area: 17000 m2; total airflow: 34m3/s; supply air temperature: 17°C, exhaust air temperature 25°C; internal heat loads 37 W/m3; cooling loads: 1189 MWh/year; operating time: 8760 h/year, SFP: 2.5 kW/(m3/s), life span: 15 years. Excerpt from the report, see 'Publication': ''Air handling units for technical equipment are excluded from the calculations. (...) In this study, net amounts of raw material in each specific component of the AC system system are included. Manufacturing processes of components, as well as wastes related to these processes, are excluded from the study. Moreover, all transports of materials and components between the different places of their production and assembly of the AC system are assumed to be comparable apart from its type, and therefore excluded from the study. Minor materials, whose weight is represented by less than 1% of the total weight of a component, are excluded from calculations as their impact is neglected campared to the whole AC system and its use. Furthermore, the ducts of the cooling medium and the pumps in the vapour compressor chiller, as well as the brine ducts connecting the vapour compressor chiller with the cooling coil in the air handling unit (...) are not included. Impacts of air dampers and silencers in the air distribution system are assumed to be comparable with impact of air ducts. Various types of valves in the water distribution system are assumed to have the same environmental performance as the ducts. Material amounts of branch ducts of both distribution systems, air and water, are neglected as they are small compared to the material amounts of the whole AC system. Environmental impacts of the refrigerant of the vapour compressor chiller are calculated only as emission due to missing inventory data for the manufacturing processes. The disposal phase of the life cycle of the system is not inlcuded in the study, because of the

	uncertainty of a possible waste scenario that can not be affected by designers at the design stage.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2001
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''The study is based on regular documentation, such as calculations and drawings, at an early stage of the design process. (...) The inventory data for materials used in the AC system was compiled using a software application EPS Design System 4.''
Literature Reference	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/Heikkila_et_al_2007
Notes	NB: note that the data relate only to production of materials and the use phase.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Resource	Aluminium ore	3.31E+03			kg	Ground	Sweden
	Input	Resource	Chromium ore	1.64E+01			kg	Ground	Sweden
	Input	Resource	Coal in ground	3.76E+06			kg	Ground	Sweden
	Input	Resource	Copper ore	3.72E+03			kg	Ground	Sweden
	Input	Resource	Iron ore	4.91E+04			kg	Ground	Sweden
	Input	Resource	Molybdenum ore	7.00E-01			kg	Ground	Sweden
	Input	Resource	Nickel ore	7.30E+00			kg	Ground	Sweden
	Input	Resource	Oil in the ground	5.40E+05			kg	Ground	Sweden
	Input	Resource	Zinc ore	3.45E+02			kg	Ground	Sweden
	Output	Emission	BOD	6.00E-02			kg	Water	Sweden
	Output	Emission	CH4	3.96E+03			kg	Air	Sweden
	Output	Emission	CO	2.39E+02			kg	Air	Sweden
	Output	Emission	CO2	1.17E+07			kg	Air	Sweden
	Output	Emission	COD	1.55E+01			kg	Water	Sweden
	Output	Emission	Dust	5.18E+01			kg	Water	Sweden
	Output	Emission	Formaldehyde	1.15E+01			kg	Air	Sweden
	Output	Emission	HFC-125	1.36E+02			kg	Air	Sweden
	Output	Emission	HFC-32	1.36E+02			kg	Air	Sweden
	Output	Emission	N2O	7.00E-03			kg	Air	Sweden
	Output	Emission	NMVOC	9.23E+01			kg	Air	Sweden
	Output	Emission	NOx	2.60E+04			kg	Air	Sweden
	Output	Emission	N-tot	6.00E-01			kg	Water	Sweden
	Output	Emission	PAH	2.00E-01			kg	Air	Sweden
	Output	Emission	P-tot	6.00E-02			kg	Water	Sweden
	Output	Emission	SOx	8.44E+04			kg	Air	Sweden

About Inventory

Publication	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''An objective of this work was that it should lead to an increased knowledge of how to work with environmental issues related to air-conditioning systems for office buildings and to a greater awareness of the environmental loads related to these systems. (...) The objectives of this thesis are to: - describe how the environmental performance of air-conditioning systems can be assessed and evaluated at the design stage. The focus is on the application of existing methods for

	environmental assessment of these systems. - identify and discuss the major sources of the environmental impacts and give some general recommendations as to how to design air-conditioning systems to improve their environmental performance. - outline possible key performance indicators (KPI) for the environmental performance of the most common types of air-conditioning systems.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The primary task in this case study is to account for the environmental performance of the designed system to the customer. (...) The results are intended for an internal usage in the company designing the AC system.''
Commissioner	Unknown - .
Practitioner	Katarina Heikkilä - .
Reviewer	Jan-Olof Dalenbäck, Torbjörn Lindholm, - Building Services Engineering, Energy and Environment, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	For more information and the comparison with the other systems see the report. The reference report is a thesis for the degree of doctor. As a part of it, seven papers are included. Paper III ''Evaluation of environmental impacts of air-conditioning systems at the design stage'' relates to the analysis of air-and-water system. The function and other information was taken from the mentioned Paper III. Inventory data come from the main part of the report.

SPINE LCI dataset: Airbag's can production. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Airbag's can production. Autoliv ESA-DBP
Functional Unit	1 unit of can
Functional Unit Explanation	1 can weighs 240 grams while the whole airbag weighs 1.56 kg
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The can is a part of the airbag produced by Autoliv which is a construction frame for the rest of the parts: cushion, inflator and the cover. A frame is common for different constructions where the solid frame or base are needed. Similar part with comparable function can be found in a seatbelt and it is called 'frame'. The can is produced in Sweden. It is made of zinc galvanized steel and is assembled with snap in pinne. It weighs 240 grams.

	The manufacturing process consists of the following steps: 1. Slitting the steel sheet 2. Punching on stamping press machine 3. Zinc galvanization 4. Assembling with the base can This process is included in the system described in: Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf Other processes in the CPM Database also included in the above publication: - Airbag's cushion manufacturing. Autoliv ESA-DBP - Airbag's igniter granules manufacturing. Autoliv ESA-DBP - Airbag's inflator assembly. Autoliv ESA-DBP - Airbag's initiator assembly. Autoliv ESA-DBP - Airbag's label manufacturing. Autoliv ESA-DBP - Airbag's nut manufacturing. Autoliv ESA-DBP - Airbag's shunt ring manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with processing the materials from the suppliers and ends with assembling the final product. Data given by can manufacturer do not show any emissions. Steel scrap is produced.
Time Boundary	The data were acquired in 2009.
Geographical Boundary	The manufacturer is located in Sweden.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''The production infrastructure, maintenance and capital goods as well as personnel related environmental impact are excluded in this study.''
Allocations	The allocation procedure was applicable in case of electricity and water consumption. Those values were given for the annual production. Allocation was based on the value on annual production and value of studied product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--1.pdf
Notes	NB: note that the data relate only to production of materials and the use phase.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: 1 product weighs 22.7 grams.	Input	Input Product	Snap in pinne	2			pce	Technosphere	
	Input	Natural resource	Water	4.00E-04			m3	Water	
	Input	Refined resource	Electricity	1.94E-01			MJ	Technosphere	
	Input	Refined resource	Steel	1.99E+02			g	Technosphere	
	Output	Product	Can	1			pce	Technosphere	
	Output	Residue	Steel scrap	3.97E+00			g	Technosphere	

About Inventory

Publication	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://cpmdatabase.cpm.chalmers.se/DataReferences

	/ESA_2010--1.pdf>http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed can is a part of the airbag which was the object of the study. The main goals of the study are: (excerpt from the report, see 'Literature reference') ''1. To identify the environmental impacts that can be associated with the airbag. 2. To analyze several environmental impacts such as consumption of different resources, e.g. energy, water, materials, etc., emissions of specific pollutants such as CO2, NOx, SO2, etc. and amount of generated wastes. 3. To determine the relative environmental load of the airbag package compared to a complete car. 4. To determine whether there are materials in the product that should be avoided for environmental reasons.''
Commissioner	Autoliv Development AB - .
Practitioner	Arief Mujiyanto & Susetyo Priyojati - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the airbag is shredded together with the car. Before that it has to be deployed in the specialized garage. The assumption made in the project says that 80% of the airbag will be recycled. The rest consists mainly of resins, rubber, glass, textile etc. The studied product is a part of the airbag which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the airbag, 3 other LCA studies for Autoliv were carried out (for seatbelt, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Airbag's cushion manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Airbag's cushion manufacturing. Autoliv ESA-DBP
Functional Unit	1 unit of cushion
Functional Unit Explanation	1 cushion weighs 290 grams while the whole airbag module 1560 grams
Process Type	Gate to gate
Site	Unknown

Sector	Manufacturing
Owner	Unknown
Technical system description	The studied cushion is a part of a driver's airbag which is filled with the gas after the crash. It is the white 'bag' which is inflated and protects the occupant against hitting the steering wheel or other parts in the car. The cushion is manufactured in Portugal. It consists of 4 main parts: polyamide 6.6 fabric and thread, reinforcing glass fibre, and a label. The cushion weighs 290 grams. The production process consists of the following steps: 1. Spreading and cutting the fabrics 2. Marking the fabric with folding and cutting pattern 3. Sewing the pieces 4. Laser cutting 5. Enveloping the seams 6. Folding and labeling 7. Metal detection and packing This process is included in the system described in: Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf Other processes in the CPM Database also included in the above publication: - Airbag's can production. Autoliv ESA-DBP - Airbag's igniter granules manufacturing. Autoliv ESA-DBP - Airbag's inflator assembly. Autoliv ESA-DBP - Airbag's initiator assembly. Autoliv ESA-DBP - Airbag's label manufacturing. Autoliv ESA-DBP - Airbag's nut manufacturing. Autoliv ESA-DBP - Airbag's shunt ring manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with spreading and cutting the fabrics and ends with metal detection and packing. Data given by cushion manufacturer do not show any emissions. The fabric and thread waste is produced.
Time Boundary	The data were acquired in 2009. Data for electricity and water consumption come from July-September 2009.
Geographical Boundary	The manufacturing plant is located in Portugal.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''The production infrastructure, maintenance and capital goods as well as personnel related environmental impact are excluded from this study.''
Allocations	The allocation procedure was applicable in case of electricity and water. Those values were given for the monthly production. Allocation was based on the value on monthly production and value of studied product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf
Notes	NB: note that the data relate only to production of materials and the use phase.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Input Product	Label	1			pce	Technosphere	
	Input	Natural resource	Water	5.40E-03			m3	Water	
	Input	Refined resource	Electricity	6.96E-01			MJ	Technosphere	

Notes: made from polyamid glass fibre	Input	Refined resource	Kevlar thread	2.70E-01			g	Technosphere	
	Input	Refined resource	Polyamide 66 fibre	2.89E+02			g	Technosphere	
	Input	Refined resource	Polyamide 66 thread	1.19E+01			g	Technosphere	
Notes: The product weighs 290 grams and it is transported Autoliv Sweden in Vårgårda where is assembled into the airbag.	Output	Product	Cushion	1			pce	Technosphere	
Notes: Fully recycled	Output	Residue	Fabric waste	1.56E+01			g	Technosphere	
Notes: Fully recycled.	Output	Residue	Thread waste	1.22E+01			g	Technosphere	

About Inventory	
Publication	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://cpmdatabase.cpm.chalmers.se/DataReferences /ESA_2010--1.pdf>http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed cushion is a part of the airbag which was the object of the study. The main goals of the study are: (excerpt from the report, see 'Literature reference') ''1. To identify the environmental impacts that can be associated with the airbag. 2. To analyze several environmental impacts such as consumption of different resources, e.g. energy, water, materials, etc., emissions of specific pollutants such as CO2, NOx, SO2, etc. and amount of generated wastes. 3. To determine the relative environmental load of the airbag package compared to a complete car. 4. To determine whether there are materials in the product that should be avoided for environmental reasons.''
Commissioner	Autoliv Development AB - .
Practitioner	Arief Mujiyanto & Susetyo Priyojati - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the airbag is shredded together with the car. Before that it has to be deployed in the specialized garage. The assumption made in the project says that 80% of the airbag will be recycled. The rest consists mainly of resins, rubber, glass, textile etc. The cushion is recycled and used for making vacuum surge tanks. The studied product is a part of the airbag which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the airbag, 3 other LCA studies for Autoliv were carried out (for seatbelt, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Airbag's igniter granules manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Airbag's igniter granules manufacturing. Autoliv ESA-DBP
Functional Unit	1kg of igniter granules
Functional Unit Explanation	For the Autoliv's airbag with the weight 1560 grams igniter granules were needed in amount of 1.24 gram.
Process Type	Unit operation
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Igniter granules consist of the explosive material guanidine nitrate and the oxidizer potassium nitrate. They are placed in the inflator and when the crash occurs, the sensors from the car send the signals to the Airbag Control Unit, from where the signals go to initiator. The initiator creates electrical impulses and produces high temperature in order to make the explosive material explode. The explosion can occur thanks to the oxidizer that is stored close to the guandine nitrate. The nitrogen gas fulfills the cushion which protects the occupant against hitting the steering wheel or other parts in the car. Manufacturing process description is not available due to confidentiality. This process is included in the system described in: Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf Other processes in the CPM Database also included in the above publication: - Airbag's can production. Autoliv ESA-DBP - Airbag's cushion manufacturing. Autoliv ESA-DBP - Airbag's inflator assembly. Autoliv ESA-DBP - Airbag's initiator assembly. Autoliv ESA-DBP - Airbag's label manufacturing. Autoliv ESA-DBP - Airbag's nut manufacturing. Autoliv ESA-DBP - Airbag's shunt ring manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	Data about the production process are confidential.
Time Boundary	Data were acquired in 2009.
Geographical Boundary	The manufacturing plant is located in USA.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Data were delivered in a unit per 1 inflator.
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.

Literature Reference	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf>http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf
Notes	Energy consumption data were not available.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Water	9.70E+01			g	Technosphere	
	Input	Refined resource	Boron	1.42E+02			g	Technosphere	
	Input	Refined resource	Ethanol	9.70E+01			g	Technosphere	
	Input	Refined resource	Guandine nitrate	1.94E+02			g	Technosphere	
	Input	Refined resource	Potasium nitrate	4.70E+02			g	Technosphere	
	Output	Product	Igniter granules	1.00E+03			g	Technosphere	

About Inventory

Publication	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://cpmdatabase.cpm.chalmers.se/DataReferences /ESA_2010--1.pdf>http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed igniter granules are the parts of the airbag which was the object of the study. The main goals of the study are: (excerpt from the report, see 'Literature reference') ''1. To identify the environmental impacts that can be associated with the airbag. 2. To analyze several environmental impacts such as consumption of different resources, e.g. energy, water, materials, etc., emissions of specific pollutants such as CO2, NOx, SO2, etc. and amount of generated wastes. 3. To determine the relative environmental load of the airbag package compared to a complete car. 4. To determine whether there are materials in the product that should be avoided for environmental reasons''
Commissioner	Autoliv Development AB - .
Practitioner	Arief Mujiyanto & Susetyo Priyojati - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the airbag is shredded together with the car. Before that it has to be deployed in the specialized garage. The assumption made in the project says that 80% of the airbag will be recycled. The rest consists mainly of resins, rubber, glass, textile etc. The studied product is a part of the airbag which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the airbag, 3 other LCA studies for Autoliv were carried out (for seatbelt, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Airbag's inflator assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Airbag's inflator assembly. Autoliv ESA-DBP
Functional Unit	1 unit of inflator
Functional Unit Explanation	1 airbag inflator weighs 666.34 grams and it is a part of the airbag which weighs 1560 grams
Process Type	Unit operation
Site	Autoliv IRO. Brasov, Romania.
Sector	Manufacturing
Owner	Autoliv IRO. Brasov, Romania.
Technical system description	The inflator is the part of the airbag responsible for airbag deployment. In this part gas generant, initiator and many other components are placed. When a crash occurs, the sensors from the car send the signals to the Airbag Control Unit, from where the signals go to initiator. The initiator creates electrical impulses and produces high temperature in order to make a gas generant explode. The gas fills the cushion and protects the occupant against hitting the steering wheel or other parts in the car. In addition to initiator and gas generant, the inflator consists also of: diffuser, base, adapter, seal washer, igniter tube, cup, cap, filter, pad damper, retainer disk, caution label and clinching stud. It weighs 666.34 grams. The inflator is assembled in Autoliv Romania. The process consists of the following steps: 1. Welding some metal parts 2. Pouring the gas generant 3. Leakage check by using helium 4. Electrical check 5. Putting the labels This process is included in the system described in: Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf Other processes in the CPM Database also included in the above publication: - Airbag's can production. Autoliv ESA-DBP - Airbag's cushion manufacturing. Autoliv ESA-DBP - Airbag's igniter granules manufacturing. Autoliv ESA-DBP - Airbag's initiator assembly. Autoliv ESA-DBP - Airbag's label manufacturing. Autoliv ESA-DBP - Airbag's nut manufacturing. Autoliv ESA-DBP - Airbag's shunt ring manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is a unit operation. It starts with welding the metal parts and ends with putting the labels. Data given by inflator manufacturer do not show any emissions.
Time Boundary	The data were acquired in 2009 but they come from 2008.
Geographical Boundary	The manufacturing plant is located in Romania.
Other Boundaries	Excerpt from the report, see 'Literature reference': "Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included."
Allocations	The allocation procedure was applicable in case of electricity and water. Those values were given for the annual production. Allocation was based on the value on annual production and value of studied product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf>http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf
Notes	Energy consumption data were not available.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: The product weighs 19.4 grams	Input	Input Product	Adapter	2			pce	Technosphere	
	Input	Input Product	Adapter barrel	1			pce	Technosphere	
Notes: The product weighs 180 grams	Input	Input Product	Base	1			pce	Technosphere	
Notes: The product weighs 0.03 gram	Input	Input Product	Caution label	1			pce	Technosphere	
Notes: The product weighs 3.54 grams	Input	Input Product	Damper pad	1			pce	Technosphere	
	Input	Input Product	Damper pad 2	1			pce	Technosphere	
Notes: The product weighs 155 grams	Input	Input Product	Diffuser	1			pce	Technosphere	
	Input	Input Product	End cap	1			pce	Technosphere	
Notes: The product weighs 0.68 gram	Input	Input Product	Foil	2			pce	Technosphere	
Notes: The product weighs 35.57 gram	Input	Input Product	Generant cup	1			pce	Technosphere	
Notes: The product weighs 0.454 gram	Input	Input Product	Green shunt ring	1			pce	Technosphere	
	Input	Input Product	Igniter granules	2.30E+00			g	Technosphere	
Notes: The product weighs 0.475 gram	Input	Input Product	Ignition cup	2			pce	Technosphere	
	Input	Input Product	Ignition tube	1			pce	Technosphere	
Notes: The product weighs 11.044 grams	Input	Input Product	Initiator	2			pce	Technosphere	
	Input	Input Product	Powder generant	5.60E+01			g	Technosphere	
	Input	Input Product	Protective cap	2			pce	Technosphere	
Notes: The product weighs 0.4543 gram	Input	Input Product	Purple shunt ring	1			pce	Technosphere	
Notes: The product weighs 15.43 grams	Input	Input Product	Retainer disk	1			pce	Technosphere	
Notes: The product weighs 2.5 grams	Input	Input Product	Stud 1	4			pce	Technosphere	
	Input	Input Product	Stud 2	4			pce	Technosphere	
	Input	Input Product	TBD filter	1			pce	Technosphere	
Notes: The product weighs 0.03 gram	Input	Input Product	Tracing label	1			pce	Technosphere	
Notes: The product weighs 0.06 gram	Input	Input Product	Washer seal 1	2			pce	Technosphere	
	Input	Input Product	Washer seal 2	2			pce	Technosphere	
	Input	Natural resource	Water	1.00E-04			m3	Water	
	Input	Refined resource	Electricity	5.05E-01			MJ	Technosphere	
Notes: The product weighs 666.34 grams	Output	Product	Inflator	1			pce	Technosphere	

About Inventory

Publication	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://cpmdatabase.cpm.chalmers.se/DataReferences /ESA_2010--1.pdf>http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf
Intended User	Autoliv, LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the followed products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed inflator is the part of the airbag which was the object of the study. The main goals of the study are: (excerpt from the report, see 'Literature reference') ''1. To identify the environmental impacts that can be associated with the airbag. 2. To analyze several environmental impacts such as consumption of different resources, e.g. energy, water, materials, etc., emissions of specific pollutants such as CO2, NOx, SO2, etc. and amount of generated wastes. 3. To determine the relative environmental load of the airbag package compared to a complete car. 4. To determine whether there are materials in the product that should be avoided for environmental reasons.''
Commissioner	Autoliv Development AB - .
Practitioner	Arief Mujiyanto & Susetyo Priyojati - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the airbag is shredded together with the car. Before that it has to be deployed in the specialized garage. The assumption made in the project says that 80% of the airbag will be recycled. The rest consists mainly of resins, rubber, glass, textile etc. The studied product is a part of the airbag which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the airbag, 3 other LCA studies for Autoliv were carried out (for seatbelt, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Airbag's initiator assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Airbag's initiator assembly. Autoliv ESA-DBP
Functional Unit	1 unit of initiator

Functional Unit Explanation	1 initiator weighs 11.044 grams while the airbag weighs 1560 grams.
Process Type	Unit operation
Site	Autoliv ITO. Tremonton, Utah, US.
Sector	Manufacturing
Owner	Autoliv ITO. Tremonton, Utah, US.
Technical system description	The initiator is a part of the airbag and it is placed in inflator. When the crash occurs, the sensors from the car send the signals to the Airbag Control Unit, from where the signals go to initiator. The initiator creates electrical impulses and produces high temperature in order to make a gas generant explode. The gas fills the cushion which protects the occupant against hitting the steering wheel or other parts in the car. The initiator is assembled in Autoliv in US and transported to Autoliv Romania. It consists of overmoulding, bridgewire, cruciformed cup, ignition fuel, insulation cover, chargeholder and header. It weighs 11 grams. The process consists of the following steps: 1. Drying the propellants 2. Welding the bridgewire to header 3. Welding the chargeholder to bridgewire 4. Loading the propellant 5. Welding the cup 6. Installing the cover over the cup 7. Check and inspection 8. Overmoulding This process is included in the system described in: Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf Other processes in the CPM Database also included in the above publication: - Airbag's can production. Autoliv ESA-DBP - Airbag's cushion manufacturing. Autoliv ESA-DBP - Airbag's igniter granules manufacturing. Autoliv ESA-DBP - Airbag's inflator assembly. Autoliv ESA-DBP - Airbag's label manufacturing. Autoliv ESA-DBP - Airbag's nut manufacturing. Autoliv ESA-DBP - Airbag's shunt ring manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is an unit operation. It starts with processing the materials from the suppliers and ends with dispatching to Autoliv Romania. Data given by Autoliv US do not show any emissions.
Time Boundary	Data were acquired in 2009.
Geographical Boundary	Manufacturing plant is located in USA.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of electricity and water consumption. Those values were given for the annual production. Allocation was based on the value on annual production and value of studied product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf>http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf
Notes	Energy consumption data were not available.

Flow Table and Specific Meta Data									
QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: The weight of the product is 0.298 gram	Input	Input Product	Bridgewire	1			pce	Technosphere	
Notes: The weight of the product is 7.81 grams	Input	Input Product	Chargeholder	1			pce	Technosphere	
	Input	Input Product	Cruciformed cup	1			pce	Technosphere	
Notes: The weight of the product is 0.958 gram	Input	Input Product	Header	1			pce	Technosphere	
Notes: The product weighs 0.05 gram	Input	Input Product	Insulation cover	1			pce	Technosphere	
	Input	Natural resource	Water	4.02E-07			m3	Technosphere	
	Input	Refined resource	Electricity	5.48E-02			MJ	Technosphere	
	Input	Refined resource	Polyamide 66 (PA66)	2.98E-01			g	Technosphere	
	Input	Refined resource	Potasium perchlorate	8.9E-02			g	Technosphere	
	Input	Refined resource	Zirconium powder	1.24E-01			g	Technosphere	
Notes: The weight of the product is 11.044 grams	Output	Product	Initiator	1			pce	Technosphere	

About Inventory	
Publication	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://cpmdatabase.cpm.chalmers.se/DataReferences /ESA_2010--1.pdf>http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed initiator is the part of the airbag which was the object of the study. The main goals of the study are: (excerpt from the report, see 'Literature reference') ''1. To identify the environmental impacts that can be associated with the airbag. 2. To analyze several environmental impacts such as consumption of different resources, e.g. energy, water, materials, etc., emissions of specific pollutants such as CO2, NOx, SO2, etc. and amount of generated wastes. 3. To determine the relative environmental load of the airbag package compared to a complete car. 4. To determine whether there are materials in the product that should be avoided for environmental reasons.''
Commissioner	Autoliv Development AB - .
Practitioner	Arief Mujiyanto & Susetyo Priyojati - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the airbag is shredded together with the car. Before that it has to be deployed in the specialized garage. The assumption made in the project says that 80% of the airbag will be recycled. The rest consists mainly of resins, rubber, glass, textile etc. The studied product is a part of the airbag which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the airbag, 3 other LCA studies for Autoliv were carried out (for seatbelt, night vision camera and electronic control unit). Some of the processes can be found also in the CPM

	database.

SPINE LCI dataset: Airbag's label manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Airbag's label manufacturing. Autoliv ESA-DBP
Functional Unit	1 label
Functional Unit Explanation	1 label weighs 1 gram while airbag weighs 1560 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The label is used for attaching information to the product. This particular label is attached to an airbag, produced by Autoliv. It is made of polyethylene and it weighs 1 gram. The manufacturing process of label takes place in Sweden and consists of the following steps: - preparing the polyethylene film by extruding polyethylene granule with extrusion molding machine - cutting the film among the edge - adding the adhesive to the surface of the film - printing information on the label This process is included in the system described in: Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf Other processes in the CPM Database also included in the above publication: - Airbag's can production. Autoliv ESA-DBP - Airbag's cushion manufacturing. Autoliv ESA-DBP - Airbag's igniter granules manufacturing. Autoliv ESA-DBP - Airbag's inflator assembly. Autoliv ESA-DBP - Airbag's initiator assembly. Autoliv ESA-DBP - Airbag's nut manufacturing. Autoliv ESA-DBP - Airbag's shunt ring manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is gate-to-gate. It starts producing the polyethylene film and finished with ink. Data given by label manufacturer do not show any emissions.
Time Boundary	Data were acquired in 2009. Data come from July 2009.
Geographical Boundary	The manufacturing plant is located in Sweden.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of electricity and water consumption. Those values were given for the monthly production. Allocation was based on the number of labels produced in July 2009.

Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf>http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf
Notes	Energy consumption data were not available.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	1.38E-05			m3	Water	Sweden
	Input	Refined resource	Adhesive	3.97E-01			g	Technosphere	Sweden
	Input	Refined resource	Electricity	9.59E-05			MJ	Technosphere	Sweden
Notes: the amount depends on the content	Input	Refined resource	Ink	0.00E+00			g	Technosphere	Sweden
	Input	Refined resource	Polyethylene	6.41E-01			g	Technosphere	Sweden
	Output	Product	Label	1			pce	Technosphere	Sweden
Notes: estimation - ca. 5%	Output	Residue	Waste	5.46E-02			g	Technosphere	Sweden

About Inventory

Publication	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://cpmdatabase.cpm.chalmers.se/DataReferences /ESA_2010--1.pdf>http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf
Intended User	Autoliv, LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed label is a part of the airbag which was the object of the study. The main goals of the study are: (excerpt from the report, see 'Literature reference') ''1. To identify the environmental impacts that can be associated with the airbag. 2. To analyze several environmental impacts such as consumption of different resources, e.g. energy, water, materials, etc., emissions of specific pollutants such as CO2, NOx, SO2, etc. and amount of generated wastes. 3. To determine the relative environmental load of the airbag package compared to a complete car. 4. To determine whether there are materials in the product that should be avoided for environmental reasons.''
Commissioner	Autoliv Development AB - .
Practitioner	Arief Mujiyanto & Susetyo Priyojati - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA).

	Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the airbag is shredded together with the car. Before that it has to be deployed in the specialized garage. The assumption made in the project says that 80% of the airbag will be recycled. The rest consists mainly of resins, rubber, glass, textile etc. The studied product is a part of the airbag which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the airbag, 3 other LCA studies for Autoliv were carried out (for seatbelt, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Airbag's nut manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Airbag's nut manufacturing. Autoliv ESA-DBP
Functional Unit	1 nut
Functional Unit Explanation	1 nut weighs 1.7 gram while the whole airbag weighs 1560 grams. 4 nuts are needed for 1 airbag.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The nut is used for fasting components. In case of Autoliv's airbag 4 nuts are used during the installation of the airbag in the steering wheel. They are made of steel and coated with zinc. The weight of each is 1.7 gram. The nuts' supplier is located in Sweden but the production takes place in Taiwan. The manufacturing process consists of the following steps: 1. Cutting the steel bar 2. Threading with the tapping machine 3. Zinc coating This process is included in the system described in: Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf Other processes in the CPM Database also included in the above publication: - Airbag's can production. Autoliv ESA-DBP - Airbag's cushion manufacturing. Autoliv ESA-DBP - Airbag's igniter granules manufacturing. Autoliv ESA-DBP - Airbag's inflator assembly. Autoliv ESA-DBP - Airbag's initiator assembly. Autoliv ESA-DBP - Airbag's label manufacturing. Autoliv ESA-DBP - Airbag's shunt ring manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with cutting the steel bars and ends with zinc coating. Data given by nut manufacturer do not show any emissions. The steel scrap is produced though.
Time Boundary	Data were acquired in October 2009. The data come from the same year.
Geographical Boundary	The manufacturer is located in Taiwan.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of electricity and water consumption. Those values were given for the monthly production and multiplied by 12. Allocation was based on the value of annual production and value of studied product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf>http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf
Notes	Energy consumption data were not available.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	4.00E-04			m3	Water	Taiwan
	Input	Refined resource	Electricity	5.53E-03			MJ	Technosphere	Taiwan
	Input	Refined resource	e-plate zinc	2.50E-02			g	Technosphere	
	Input	Refined resource	Steel bar	1.76E+00			g	Technosphere	
	Output	Product	Nut	1			pce	Technosphere	
	Output	Residue	Steel scrap	9.25E-02			g	Technosphere	Taiwan

About Inventory

Publication	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://cpmdatabase.cpm.chalmers.se/DataReferences /ESA_2010--1.pdf>http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed nut is a part of the airbag which was the object of the study. The main goals of the study are: (excerpt from the report, see 'Literature reference') ''1. To identify the environmental impacts that can be associated with the airbag. 2. To analyze several environmental impacts such as consumption of different resources, e.g. energy, water, materials, etc., emissions of specific pollutants such as CO2, NOx, SO2, etc. and amount of generated wastes. 3. To determine the relative environmental load of the airbag package compared to a complete car. 4. To determine whether there are materials in the product that should be avoided for environmental reasons.''
Commissioner	Autoliv Development AB - .
Practitioner	Arief Mujiyanto & Susetyo Priyojati - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -

Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the airbag is shredded together with the car. Before that it has to be deployed in the specialized garage. The assumption made in the project says that 80% of the airbag will be recycled. The rest consists mainly of resins, rubber, glass, textile etc. The studied product is a part of the airbag which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the airbag, 3 other LCA studies for Autoliv were carried out (for seatbelt, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Airbag's shunt ring. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Airbag's shunt ring. Autoliv ESA-DBP
Functional Unit	1 unit of shunt ring
Functional Unit Explanation	1 shunt ring weighs 0.4543 gram and is a part of the airbag which weighs 1560 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The shunt ring is a part in the airbag's inflator which stabilizes the initiator. There are 2 shunt rings in the studied inflator; one green and one purple. They have the same content and they weigh 0.45 gram. They might be used in other products as well for example for stabilizing purpose. Shunt rings are produced in Germany. The manufacturing process starts with injection molding. In parallel the pin is produced from copper alloy which is coated with gold and nickel. In the end of the process the pin is attached to the ring. This process is included in the system described in: Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF:http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf Other processes in the CPM Database also included in the above publication: - Airbag's can production. Autoliv ESA-DBP - Airbag's cushion manufacturing. Autoliv ESA-DBP - Airbag's igniter granules manufacturing. Autoliv ESA-DBP - Airbag's inflator assembly. Autoliv ESA-DBP

	- Airbag's initiator assembly. Autoliv ESA-DBP - Airbag's label manufacturing. Autoliv ESA-DBP - Airbag's nut manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with processing the materials and ends with assembling plastic and metal parts. Data given by the shunt ring manufacturer do not show any emissions.
Time Boundary	The data were acquired in 2009 and they come from 2008.
Geographical Boundary	The manufacturing plant is located in Germany.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of electricity and water. Those values were given for the annual production. Allocation was based on the value on annual production and value of studied product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf>http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--1.pdf
Notes	Energy consumption data were not available.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	2.00E-03			m3	Technosphere	Germany
	Input	Refined resource	Au	1.13E-04			g	Technosphere	
	Input	Refined resource	CuBe2 alloy	6.00E-02			g	Technosphere	
	Input	Refined resource	Electricity	7.20E-04			MJ	Technosphere	Germany
	Input	Refined resource	Ni	4.20E-03			g	Technosphere	
	Input	Refined resource	Polybutylene terephthalate	3.90E-01			g	Technosphere	
Notes: The finished product is then transported to Autoliv Romania to be assembled into inflator.	Output	Product	Shunt ring	1			pce	Technosphere	
	Output	Residue	Scrap	9.27E-03			g	Technosphere	

About Inventory

Publication	Mujiyanto A., Priyojati S. (2010). Life cycle assessment of Autoliv's Driver Airbag. Master thesis report. ESA report 2010:1, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: a href=http://cpmdatabase.cpm.chalmers.se/DataReferences /ESA_2010--1.pdf>http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--1.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.

Detailed Purpose	The discussed shunt ring is the part of the airbag which was the object of the study. The main goals of the study are: (excerpt from the report, see 'Literature reference') ''1. To identify the environmental impacts that can be associated with the airbag. 2. To analyze several environmental impacts such as consumption of different resources, e.g. energy, water, materials, etc., emissions of specific pollutants such as CO2, NOx, SO2, etc. and amount of generated wastes. 3. To determine the relative environmental load of the airbag package compared to a complete car. 4. To determine whether there are materials in the product that should be avoided for environmental reasons.''
Commissioner	Autoliv Development AB - .
Practitioner	Arief Mujiyanto & Susetyo Priyojati - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the airbag is shredded together with the car. Before that it has to be deployed in the specialized garage. The assumption made in the project says that 80% of the airbag will be recycled. The rest consists mainly of resins, rubber, glass, textile etc. The studied product is a part of the airbag which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the airbag, 3 other LCA studies for Autoliv were carried out (for seatbelt, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Air-conditioning system. ESA-DBP

Administrative	
Finished	Y
Date Completed	2007
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Air-conditioning system. ESA-DBP
Functional Unit	Air-conditioning system which conditions and distributes a variable airflow volume (VAV) of a max. 5 m3/s
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The air-conditioning system includes the cooling and the air distribution systems. The required temperature of the supply is 15 °C all during the year, and the room temperature varies from 20 °C to 25.5 °C. The system operates for 11h (7am-18pm) each working day, 5 days a week. The lifesplan of this system as an entity is estimated to be 15 years.'' The data are valid for 1 year.
Process Type	Cradle to gate
Site	Unknown
Sector	Goods and services for households

Owner	Unknown
Technical system description	Schematics of the system can be found in the reference report (see 'Publication'). This particular air-conditioning system was used for comparison with bore-hole system (see 'Bore-hole based air-conditioning system. ESA-DBP'). The discussed system was (excerpt from the report, see 'Publication') '' designed to meet the same requirements, but with more traditional sources for heating (district heating) and cooling (refrigeration). ''The air-conditioning system studied was installed to provide a building complex with ventilating air which should also lead off the surplus heat from the premises. (...) The gross area of the premises is 5000 m2, or 2500 m2 for each of the buildings. (...) The system (...) consists of an air-handling unit, an air distribution system(...). The source of cooling energy is, in this particular system, an ordinary chiller. Calculations of materials and energy use for the two air-conditioning systems are based on the design documents for system A (NB: bore-hole system), since both system alternatives are designed for the same building. (...) Although the disposition of the storeys differs slightly, for the estimation of the energy use, they are assumed to be similar. The total net area of the buildings is 1920 m2, which is mostly divided into cell offices and an auditorium for 150 persons. The total internal loads are assumed to be 40 W/m2, accounting for 10 W/m2 for people, and 15 W/m2 each for lighting and computerised equipment. (...) The production stage includes the assembly of the air distribution system in the building. User stage of the life cycle includes electricity for operation of the air-handling unit and the cooling system, required heat energy, and the leakage of the refrigerant. (...) Electricity amounts for operation of the air-handling units are estimated by using a specific fan power (SFP) factor of 1.1 kW/(m3/s) when distributing 80% of the maximum airflow, which corresponds with an SFP of 2.1 for the maximum airflow. Air is distributed in the building via a novel construction of a VAV supply air volumes at low air temperatures, 15 °C and lower, without a draught problem. (...) The environmental impacts of the disposal stage are calculated for material recycling (metals 95%, polyethylene 90%), for inineration with energy recovery (100% of the other plastics, 10% of polyethylene), and for land-filling (5% of all metals, 100% of the mineral wool insulation). Main assumptions made for this study are (NB: based on the comparative table): all-air; vapour compression; variable airflow; air-conditioning system; life cycle phases: production, user, disposal; office area: 1920 m2; total airflow: 5 m3/s; supply air temperature: 15°C, exhaust air temperature 22.5 °C; internal heat loads 40 W/m3; cooling loads: 124 MWh/year; operating time: 8760 h/year, SFP: 1.1 kW/(m3/s), life span: 15 years. This process is included in the system described in: Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007 Other processes in the CPM Database also included in the above publication: - Bore-hole based air-conditioning system. ESA-DBP - Air-and-water air conditioning system. ESA-DBP - All-air air handling unit with a cooling coil and vapour compression chiller with a refrigerant. ESA-DBP - All-air desiccant cooling air handling unit. ESA-DBP - Operation on desiccant cooling system - a technology in air conditioning. ESA-DBP - Operation on vapour compression cooling system - a technology in air conditioning. ESA-DBP

System Boundaries

Nature Boundary	In the study production, user and disposal stages are considered. The inventory analysis included parameters describing resource use and emissions to air and water.
Time Boundary	2005
Geographical Boundary	Göteborg, Sweden
Other Boundaries	Excerpt from the report, see 'Publication': ''The environmental impact (...) is analysed by taking into account the production of materials that comprise them, the energy use for the operation of the systems, and their eventual removal. The air distribution system in the building is also included in the analysis. During the lifespan of each system, supply and exhaust air filters have to be replaced according to a predefined time schedule. As shown in earlier studies, the impact of the filter materials and their amounts (mostly sheet steel and rock wool) on the environmental performance of the whole system is negligible. Therefore, these material amounts are excluded from this analysis. Moreover, components such as silencers, dampers, various valves and screws are also excluded. Neither the transports of materials to the producers, nor to the building site, are taken into account according to the assumption that the transportation distance is equivalent for both systems and would thus not affect results.''
Allocations	Unknown

Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''The amounts of component materials for the air-handling unit are deterermined by approximations based on a previously published LCA study. (...) The life cycle inventory data for the component materials and energy sources are obtained from the software application EPS Design Systems 4.0''
Literature Reference	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/Heikkila_et_al_2007
Notes	Energy consumption data were not available.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Resource	Aluminium ore	2.66E+02			kg	Ground	Sweden
	Input	Resource	Chromium ore	1.99E+01			kg	Ground	Sweden
	Input	Resource	Coal in ground	7.58E+04			kg	Ground	Sweden
	Input	Resource	Copper ore	2.29E+01			kg	Ground	Sweden
	Input	Resource	Forestland occupation	4.11E+01			kg	Ground	Sweden
	Input	Resource	Iron ore	1.36E+03			kg	Ground	Sweden
	Input	Resource	Molybdenum ore	9.00E-01			kg	Ground	Sweden
	Input	Resource	Nickel ore	8.80E+00			kg	Ground	Sweden
	Input	Resource	Oil in the ground	7.58E+03			kg	Ground	Sweden
	Input	Resource	Zinc ore	3.54E+01			kg	Ground	Sweden
	Output	Emission	BOD	5.00E-03			kg	Water	Sweden
	Output	Emission	CH4	2.70E+00			kg	Air	Sweden
	Output	Emission	CO	7.00E+00			kg	Air	Sweden
	Output	Emission	CO2	2.06E+05			kg	Air	Sweden
	Output	Emission	COD	3.00E-01			kg	Water	Sweden
	Output	Emission	Dust	3.70E+00			kg	Other	Sweden
	Output	Emission	Formaldehyde	2.00E-01			kg	Air	Sweden
	Output	Emission	HCl	8.00E-01			kg	Air	Sweden
	Output	Emission	HFC-125	2.70E+00			kg	Air	Sweden
	Output	Emission	HFC-134a	5.80E+00			kg	Air	Sweden
	Output	Emission	HFC-32	2.60E+00			kg	Air	Sweden
	Output	Emission	Litter	2.60E+00			kg	Other	Sweden
	Output	Emission	N2O	3.00E-02			kg	Air	Sweden
	Output	Emission	NMVOC	2.20E+00			kg	Air	Sweden
	Output	Emission	NOx	5.20E+02			kg	Air	Sweden
	Output	Emission	SOx	1.25E+03			kg	Air	Sweden

About Inventory

Publication	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''An objective of this work was that it should lead to an increased knowledge of how to work with environmental issues related to air-conditioning systems for office buildings and to a greater awareness of the environmental loads related to these systems. (...) The objectives of this thesis are to: - describe how the environmental performance of air-conditioning systems can be assessed and evaluated at the design stage. The focus is on the application of existing methods for environmental assessment of these systems. - identify and discuss the major sources of the environmental impacts and give some general recommendations as to how to design air-conditioning systems to improve their

	environmental performance. - outline possible key performance indicators (KPI) for the environmental performance of the most common types of air-conditioning systems.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''Case study analyses environmental impacts related to two all-air systems with different means of cooling. One of the systems uses mainly boreholes in the ground for cooling the supply air. This system is compared to a traditional reference system that uses a chiller for conditioning the supply air.''
Commissioner	Unknown - .
Practitioner	Katarina Heikkilä - .
Reviewer	Jan-Olof Dalenbäck, Torbjörn Lindholm, - Building Services Engineering, Energy and Environment, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	For more information and the comparison with the other systems see the report. The reference report is a thesis for the degree of doctor. As a part of it, seven papers are included. Paper V ''Environmental evaluation of an air-conditioning systems supplied by cooling energy from a bore-hole based heat pump system'' relates to the analysis of the two air-conditioning systems. The function and other information was taken from the mentioned Paper V. Inventory data come from the main part of the report.

SPINE LCI dataset: All-air air handling unit with a cooling coil and vapour compression chiller with a refrigerant. ESA

Administrative	
Finished	Y
Date Completed	2007
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	All-air air handling unit with a cooling coil and vapour compression chiller with a refrigerant. ESA
Functional Unit	''One air handling unit, which distributes a constant airflow volume (CAV) of 4.8 m3/s 24h a day for 15 years.''
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The required temperature of the supply air is constant of 16°C and the room temperature varies between 20°C and 25°C.'' The data are valid for 1 year.
Process Type	Cradle to grave
Site	Unknown
Sector	Goods and services for households
Owner	Unknown
Technical system description	Schematics of the system can be found in the reference report (see 'Publication'). The studied product is (excerpt from the report, see 'Publication') ''an all-air, air handling unit with a cooling coil. A vapour compression chiller with a refrigerant completes the installation. (...) Calculations are based on a case study of an office building. The 15-storeyed building is

	designed to be situated in Stokholm, Sweden. The storeys are designed to be similar and the offices are allocated 5000 m2 of the total area of 12500 m2. The total internal loads of the offices are 33 W/m2, accounting for 33 occupants per floor (10 W/m2). Each office room has an area of 10 m2, a room height of 3 m, and outer wall space 6.6 m2, of which the window area is 4.4 m2. Although four air handling units of the same size and construction for each alternative serve the whole building, the materials and energy amounts (...) are based on calculations for one air handling unit. (...) As an entity, the life cycle of the systems is assumed to be 15 years. Occasionally, the systems must be changed or rebuilt sooner because of changes of occupants or in the use of the building. Accordingly, it would be unrealistic to assume a lifetime of more than 15 years. For the user stage of the life cycle, electricity amount (...) is calculated by using specific fan power factor (SFP) of 2.5kW/(m3/s) (...). The energy use for the compressor of the chiller (...) is calculated for 30800 kWh cooling loads per year, using the seasonal performance conditions for the chiller over a full year. (...) There is no need for heating of the supply air during the cold part of the year because of the low temperature of supply air (16°C) and the high efficiency of the heat recovery unit (74%). (...) The hourly measured weather data for the year 1990 in Stokholm, Sweden are used in the calculations. The year 1990 was chosen because the number of hours with ambient air temperatures of 16°C or more corresponds to the 10-year mean value for the period 1982-1992. The user stage of the life cycle also includes the environmental impact of the filters for supply and exhaust air (...) as well as leakage of the refrigerant. The lifetime of the filter is assumed to be one year, and the annual leakage ratio is 2% of the refrigerant charge. The environmental impact of the disposal stage is calculated for material recycling, for incileration with energy recovery and for landfilling.'' Main assumptions made for this study are (NB: based on the comparative table): all-air; constant airflow; air-handling unit; life cycle phases: production, user, disposal; office area: 1250 m2; total airflow: 4.8 m3/s; supply air temperature: 16°C, exhaust air temperature 25°C; internal heat loads 33 W/m3; 105 MWh/year; operating time: 8760 h/year, SFP: 2.5 kW/(m3/s), life span: 15 years. This process is included in the system described in: Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007 Other processes in the CPM Database also included in the above publication: - Bore-hole based air-conditioning system. ESA-DBP - Air-conditioning system. ESA-DBP - Air-and-water air conditioning system. ESA-DBP - All-air desiccant cooling air handling unit. ESA-DBP - Operation on desiccant cooling system - a technology in air conditioning. ESA-DBP - Operation on vapour compression cooling system - a technology in air conditioning. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use and emissions to air and water. Excerpt from the report, see 'Publication': ''The environmental impact is studied for the life cycle of the air-handling units, which includes production of materials that comprise the systems, materials and energy use for maintenance, and their operation, as well as disposal.''
Time Boundary	Data come from the years 1995-2001. The system was assumed to work for 15 years.
Geographical Boundary	Sweden
Other Boundaries	Excerpt from the report, see 'Publication': ''The distribution system in the building is excluded from the analysis and the environmental impact is calculated only for the air-handling units. Minor materials, such as valves and screws, are not included in the calculations. Neither the transport of materials to the producers of the air-handling units nor the transport to the building site are included in the calculations, according to the assumption that the transportation distance was comparable for both systems and would not affect results.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1995-2001

Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other reports.
Literature Reference	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/Heikkila_et_al_2007
Notes	Energy consumption data were not available.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Resource	Aluminium ore	8.02E+01			kg	Ground	Sweden
	Input	Resource	Chromium ore	8.00E-01			kg	Ground	Sweden
	Input	Resource	Coal in ground	2.63E+05			kg	Ground	Sweden
	Input	Resource	Copper ore	1.67E+01			kg	Ground	Sweden
	Input	Resource	Forestland occupation	9.70E+00			kg	Ground	Sweden
	Input	Resource	Iron in ore	4.88E+02			kg	Ground	Sweden
	Input	Resource	Molybdenum ore	4.00E-02			kg	Ground	Sweden
	Input	Resource	Nickel ore	4.00E-01			kg	Ground	Sweden
	Input	Resource	Oil in the ground	1.01E+04			kg	Ground	Sweden
	Input	Resource	Zinc ore	1.07E+01			kg	Ground	Sweden
	Output	Emission	BOD	5.00E-03			kg	Water	Sweden
	Output	Emission	CH4	8.00E-02			kg	Air	Sweden
	Output	Emission	CO	4.00E-02			kg	Air	Sweden
	Output	Emission	CO2	7.07E+05			kg	Air	Sweden
	Output	Emission	COD	1.00E-01			kg	Water	Sweden
Notes: non elementary output	Output	Emission	Dust	1.60E-01			kg	Other	Sweden
	Output	Emission	Formaldehyde	4.00E-02			kg	Air	Sweden
	Output	Emission	HFC-125	1.11E+01			kg	Air	Sweden
	Output	Emission	HFC-32	1.11E+01			kg	Air	Sweden
Notes: non elementary output	Output	Emission	Litter	2.80E+00			kg	Other	Sweden
	Output	Emission	N2O	1.00E-03			kg	Air	Sweden
	Output	Emission	NMVOC	1.20E+00			kg	Air	Sweden
	Output	Emission	NOx	1.79E+03			kg	Air	Sweden
	Output	Emission	N-tot	6.00E-04			kg	Water	Sweden
	Output	Emission	PAH	4.00E-03			kg	Air	Sweden
	Output	Emission	P-tot	1.00E-04			kg	Water	Sweden
	Output	Emission	SOx	4.29E+03			kg	Air	Sweden

About Inventory

Publication	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': "An objective of this work was that it should lead to an increased knowledge of how to work with environmental issues related to air-conditioning systems for office buildings and to a greater awareness of the environmental loads related to these systems. (...) The objectives of this thesis are to: - describe how the environmental performance of air-conditioning systems can be assessed and evaluated at the design stage. The focus is on the application of existing methods for environmental assessment of these systems. - identify and discuss the major sources of the environmental impacts and give some general recommendations as to how to design air-conditioning systems to improve their environmental performance. - outline possible key performance indicators (KPI) for the environmental performance of the most common types of air-conditioning systems."
Detailed Purpose	Excerpt from the report, see 'Publication': "This case study aims to evaluate the environmental impact of two AC systems at the design stage, to choose one of them as an appropriate alternative for a given building and for the environment."
Commissioner	Unknown - .

Practitioner	Katarina Heikkilä - .
Reviewer	Jan-Olof Dalenbäck, Torbjörn Lindholm, - Building Services Engineering, Energy and Environment, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	For more information and the comparison with the other systems see the report. The reference report is a thesis for the degree of doctor. As a part of it, seven papers are included. Paper II relates to the comparison of life cycles of vapour compression cooling and desiccant cooling systems.The function and other information was taken from the mentioned Paper II. Inventory data come from the main part of the report.

SPINE LCI dataset: All-air desiccant cooling air handling unit. ESA-DBP

Administrative	
Finished	Y
Date Completed	2007
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	All-air desiccant cooling air handling unit. ESA-DBP
Functional Unit	''One air handling unit, which distributes a constant airflow volume (CAV) of 4.8 m3/s 24h a day for 15 years.''
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The required temperature of the supply air is constant of 16°C and the room temperature varies between 20°C and 25°C.'' The data are valid for 1 year.
Process Type	Cradle to grave
Site	Unknown
Sector	Goods and services for households
Owner	Unknown
Technical system description	Schematics of the system can be found in the reference report (see 'Publication'). The studied product is (excerpt from the report, see 'Publication') ''an all-air, desiccant cooling air handling unit. (...) Calculations are based on a case study of an office building. The 15-storeyed building is designed to be situated in Stokholm, Sweden. The storeys are designed to be similar and the offices are allocated 5000 m2 of the total area of 12500 m2. The total internal loads of the offices are 33 W/m2, accounting for 33 occupants per floor (10 W/m2). Each office room has an area of 10 m2, a room height of 3 m, and outer wall space 6.6 m2, of which the window area is 4.4 m2. Although four air handling units of the same size and construction for each alternative serve the whole building, the materials and energy amounts (...) are based on calculations for one air handling unit. (...) As an entity, the life cycle of the systems is assumed to be 15 years. Occasionally, the systems must be changed or rebuilt sooner because of changes of occupants or in the use of the building. Accordingly, it would be unrealistic to assume a lifetime of more than 15 years. For the user stage of the life cycle, electricity amount (...) is calculated by using specific fan power factor (SFP) of 3.2 kW/(m3/s) (...). (...) There is no need for heating of the supply air during the cold part of the year because

	of the low temperature of supply air (16°C) and the high efficiency of the heat recovery unit (74%). (...) The temperature of the air leaving the regeneration heating coil is assumed to be constant at 55°C, and the annual heat energy is estimated by calculations for a desiccant cooling control with the following assumptions: - room temperature is 25°C, - the saturation efficiency of the supply and exhaust evaporative coolers is 80%, and - the performance of the desiccant wheel is equivalent to a commercially available component having a face velocity of 2.5 m/s and a rotor depth of 0.2 m. The hourly measured weather data for the year 1990 in Stokholm, Sweden are used in the calculations. The year 1990 was chosen because the number of hours with ambient air temperatures of 16°C or more corresponds to the 10-year mean value for the period 1982-1992. The user stage of the life cycle also includes the environmental impact of the filters for supply and exhaust air (...). The lifetime of the filter is assumed to be one year. (...) The environmental impact of the disposal stage is calculated for material recycling, for incileration with energy recovery and for landfilling.'' Main assumptions made for this study are (NB: based on the comparative table): all-air; constant airflow; air-handling unit; life cycle phases: production, user, disposal; office area: 1250 m2; total airflow: 4.8 m3/s; supply air temperature: 16°C, exhaust air temperature 25°C; internal heat loads 33 W/m3; cooling loads: 105 MWh/year; operating time: 8760 h/year, SFP: 3.2 kW/(m3/s), life span: 15 years. This process is included in the system described in: Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007 Other processes in the CPM Database also included in the above publication: - Bore-hole based air-conditioning system. ESA-DBP - Air-conditioning system. ESA-DBP - Air-and-water air conditioning system. ESA-DBP - All-air air handling unit with a cooling coil and vapour compression chiller with a refrigerant. ESA-DBP - Operation on desiccant cooling system - a technology in air conditioning. ESA-DBP - Operation on vapour compression cooling system - a technology in air conditioning. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use and emissions to air and water. Excerpt from the report, see 'Publication': ''The environmental impact is studied for the life cycle of the air-handling units, which includes production of materials that comprise the systems, materials and energy use for maintenance, and their operation, as well as disposal.''
Time Boundary	Data come from the years 1995-2001. The system was assumed to work for 15 years.
Geographical Boundary	Stokholm, Sweden
Other Boundaries	Excerpt from the report, see 'Publication': ''The distribution system in the building is excluded from the analysis and the environmental impact is calculated only for the air-handling units. Minor materials, such as valves and screws, are not included in the calculations. Neither the transport of materials to the producers of the air-handling units nor the transport to the building site are included in the calculations, according to the assumption that the transportation distance was comparable for both systems and would not affect results.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1995-2001
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other reports.
Literature Reference	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/Heikkila_et_al_2007

Notes	Energy consumption data were not available.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Resource	Aluminium ore	1.07E+02			kg	Ground	Sweden
	Input	Resource	Chromium ore	1.00E+00			kg	Ground	Sweden
	Input	Resource	Coal in ground	3.31E+05			kg	Ground	Sweden
	Input	Resource	Copper ore	6.60E+00			kg	Ground	Sweden
	Input	Resource	Forestland occupation	1.18E+01			kg	Ground	Sweden
	Input	Resource	Iron ore	5.24E+02			kg	Ground	Sweden
	Input	Resource	Molybdenum ore	5.00E-02			kg	Ground	Sweden
	Input	Resource	Nickel ore	4.00E-01			kg	Ground	Sweden
	Input	Resource	Oil in the ground	2.56E+04			kg	Ground	Sweden
	Input	Resource	Zinc ore	1.09E+01			kg	Ground	Sweden
	Output	Emission	BOD	1.00E-02			kg	Water	Sweden
	Output	Emission	CH4	1.35E+02			kg	Air	Sweden
	Output	Emission	CO	7.00E+00			kg	Air	Sweden
	Output	Emission	CO2	9.43E+05			kg	Air	Sweden
	Output	Emission	COD	3.00E-01			kg	Water	Sweden
Notes: non elementary output	Output	Emission	Dust	1.55E+00			kg	Other	Sweden
	Output	Emission	Formaldehyde	5.00E-02			kg	Air	Sweden
Notes: non elementary output	Output	Emission	Litter	3.60E+00			kg	Other	Sweden
	Output	Emission	N2O	1.00E-03			kg	Air	Sweden
	Output	Emission	NMVOC	2.70E+00			kg	Air	Sweden
	Output	Emission	NOx	2.27E+03			kg	Air	Sweden
	Output	Emission	N-tot	1.00E-03			kg	Water	Sweden
	Output	Emission	PAH	5.00E-03			kg	Air	Sweden
	Output	Emission	P-tot	1.00E-04			kg	Water	Sweden
	Output	Emission	SOx	6.18E+03			kg	Air	Sweden

About Inventory

Publication	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''An objective of this work was that it should lead to an increased knowledge of how to work with environmental issues related to air-conditioning systems for office buildings and to a greater awareness of the environmental loads related to these systems. (...) The objectives of this thesis are to: - describe how the environmental performance of air-conditioning systems can be assessed and evaluated at the design stage. The focus is on the application of existing methods for environmental assessment of these systems. - identify and discuss the major sources of the environmental impacts and give some general recommendations as to how to design air-conditioning systems to improve their environmental performance. - outline possible key performance indicators (KPI) for the environmental performance of the most common types of air-conditioning systems.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''This case study aims to evaluate the environmental impact of two AC systems at the design stage, to choose one of them as an appropriate alternative for a given building and for the environment.''
Commissioner	Unknown - .
Practitioner	Katarina Heikkilä - .
Reviewer	Jan-Olof Dalenbäck, Torbjörn Lindholm, - Building Services Engineering, Energy and Environment, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander

	(ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	For more information and the comparison with the other systems see the report. The reference report is a thesis for the degree of doctor. As a part of it, seven papers are included. Paper II ''Environmental impact assessment using a weightning method for alternative air-conditioning systems'' relates to the comparison of life cycles of vapour compression cooling and desiccant cooling systems. The function and other information was taken from the mentioned Paper II. Inventory data come from the main part of the report.

SPINE LCI dataset: Aluminium recycling by refiners

Administrative	
Finished	Y
Date Completed	2002-05-07
Copyright	EAA
Availability	Public

Technical System	
Name	Aluminium recycling by refiners
Functional Unit	1000 kg aluminium ingot
Functional Unit Explanation	Aluminium rolling or extrusion ingot
Process Type	Gate to gate
Site	Not specified. See Geographical boundaries for further information.
Sector	Materials and components
Owner	Not specified. See Geographical boundaries for further information.
Technical system description	This inventory data represents the model of used aluminium recycling practice in Europe, as operated by the aluminium refiners in an average recycling situation. The refining includes: - Scrap preparation - Melting and alloying Production of electricity is included in the system. The mix of technologies included is presented below, under the headline ''Scrap preparation'' and ''Melting and alloying''. The aluminium refiners recycle old aluminium scrap, their typical material input comprising one-third aluminium scrap from end-of-life aluminium products, the rest is new scrap i.e turnings, skimmings and dross, and aluminium metallics. Several melting processes are used. The choice of process depends upon a number of variables. These include the composition of the scrap, the process available within the given plant, and economic and scheduling priorities. A breakdown of the common melting technologies is given below, under the headline ''Information regarding secondary smelting furnaces''. Molten metal fluxing (to treat the molten metal: chemical adjustment, cleaning, yield maximisation, degassing, etc.) and filtration technology (to remove any unwanted materials prior to casting) has been developed to produce aluminium alloys of the correct quality without undue environmental impact. ----------Scrap preparation-------------------- The scrap is sorted in the following categories: 1. shredder sheet scrap (4%) 2. shredder cast scrap (6%) 3. sink and float (9%) 4. baling (15%) 5. skimmings treatment (16%) 6. turnings treatment (50%)

	--- Specification of the scrap --- OLD SCRAP Old scrap is the aluminium material which is recovered after an aluminium article has been produced, used and finally collected for recycling. Old scrap could be a used aluminium bevarage can, a car cylinder head, window frames, or electrical conductor cable. Old aluminium scrap comes into the secondary industry via a very diversified and efficient network of metal merchants and waste management companies which have the technology to recover aluminium from vehicles, household goods, etc. This is often done using heavy equipment such as shredders, thogether with magnetic separators to remove iron, sink-and-float installations, or by the use of eddy current installations to separate aluminium from other metals. NEW SCRAP New scrap is surplus material that arises during the production and fabrication of aluminium products up to the point where they are sold to the final customer. Thus extrusion discards, sheet edge trim, turnings, millings and drosses could all be described as new scrap. Most new aluminium scrap comes into the secondary industry directly from the fabricators. It is therefore of known quality and alloy, and is often uncoated. It can then be melted with little preparation, apart perhaps from baling. Some new scrap that arises during semi-finishing processes may be coated with paints, ink, or plastics. This scrap can be decoated by passing scrap through an oven or a mesh conveyer whilst hot gases are circulated through the mesh to volatilise or burn off the coating. ----------Melting and alloying-------------------- The scrap is melted in a secondary smelting furnace. Different furnaces are used for European aluminium scrap refining: 1. Rotary furnance 2. Sloping hearth furnance 3. Open well reverberatory furnance 4. Electric furnance and goes further to the process steps: 5. Holding furnance 6. Casting. Further details on the rotary furnace process step: Coated aluminium scrap is typically processed by aluminium refiners using a rotary furnance with a salt flux, yielding salt slag as a by-product. The reprocessing of salt slags to recover salt flux and aluminium oxide is part of the aluminium refiners' operations as it is carried out either by the refiner himself or by an independent reprocessing specialist. The temperature of the molten metal is adjusted and alloying additions may be made with a combination of primary metals, recovered metals and master alloys to ensure the correct chemical composition of the melt.

System Boundaries

Nature Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- Cut-off criteria through out this inventory is basically relevance, as checked by the industry expert team monitoring the work and confirmed by reviewer I. Boustead. As a rough guideline ''less than 1% of total mass'' is applied for the inputs, i.e if the input is less than 1% of the total mass, then it is not included in the inventory table. The base for the choices of included inventory parameters is not further described in the EAA report.
Time Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- The data derived from an industry survey from 1998 and includes literature data from reports dated 1998 and 1999.
Geographical Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- It is not always explicit in the report where the different included process steps take place. Data may be acquired from outside of Europe, e.g. regarding ancillary materials. See litterature references (LitteratureRef) next to the flow table (FlowMetaData) for further information about the data sources for each process step.
Other Boundaries	See Nature boundaries for a specification of the cut-off criteria that has been applied.
Allocations	Allocations are not explicitly specified in the Environmental Profile Report 2000.
Systems Expansions	System expansions are not explicitly specified in the Environmental Profile Report 2000.

Flow Data

General Activity QMetaData

Date Conceived	1998 - 1999
Data Type	Derived, unspecified
Represents	Not relevant.
Method	RECYCLING OF USED ALUMINIUM This recycling model has has been prepared through a survey of aluminium refiners carried out in 1998, with an estimated coverage of 53%. The survey specifically covered secondary refiners of various sizes, ranging in output from <5 000 tpa to major facilities with production in excess of 50 000 tpa. The survey took into account the process technology, feedstock and products, along with the input and output of the various processes. Due to the individual nature of most secondary refining plants it is not possible to publish process-specific data without the risk of exposing commercially sensitive information, because a given site usually has a unique mix of feedstock, products and process technology. See Applicability for further information. --- GENERAL INFORMATION REGARDING ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- TRANSPORTS Transport energy and air emission data have been taken from SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 ELECTRICITY For all manufacturing operations, the consumption of fossil fuels and emissions linked to electricity production was calculated according to the UCTPE 94 electrical energy model as described in BUWAL 250. Emissions from combustion only, i.e. excluding the production of the fuel, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of production and combustion of the fuels in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the reporting from the industry survey, data calculated from BUWAL 250 were always used, in view of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors.
Literature Reference	---Recycling - Aluminium scrap terms and definitions: pr EN 12258-3 - Aluminium BREF note: document prepared for the EU Commission, 1999 ---Transport energy, and electricity use, and air emissions - SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems.
Notes	In this inventory profile it is possible to identify if the emission derives from the process or the energy use, see Note-field for each specific flow.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Brown coal	49.6			kg	Ground	
	Input	Natural resource	Crude gas	233			kg	Ground	
	Input	Natural resource	Crude oil	32.3			kg	Ground	
	Input	Natural resource	Hard coal	45.8			kg	Ground	
	Input	Refined resource	Alloying additives	79.0			kg	Technosphere	
	Input	Refined resource	Aluminium scrap	1270.0			kg	Technosphere	
	Input	Refined resource	Chlorine	1.6			kg	Technosphere	
Notes: Electricity produced by nuclear and hydro power plants (nuclear 143 kWh and hydro 0,2 kWh)	Input	Refined resource	Electricity	143.20			kWh	Technosphere	
	Input	Refined resource	H2SO4	8.0			kg	Technosphere	
	Input	Refined resource	HCl	0.20			kg	Technosphere	
	Input	Refined resource	Hydraulic oil	0.0075			kg	Technosphere	
	Input	Refined resource	Light oil	0.088			kg	Technosphere	
	Input	Refined resource	Lime	7.7			kg	Technosphere	
	Input	Refined resource	NaOH	1.6			kg	Technosphere	
	Input	Refined resource	Nitrogen	1.8			kg	Technosphere	
	Input	Refined resource	Salt	13.7			kg	Technosphere	
	Input	Refined resource	Water	8.0			kg	Technosphere	
	Output	By-product	Al-Mg	0.86			kg	Technosphere	

	Output	By-product	Aluminium oxide	119			kg	Technosphere	
	Output	By-product	Iron scrap	12			kg	Technosphere	
	Output	By-product	Non-ferrous metals	42			kg	Technosphere	
	Output	Emission	Cl-	0.050			kg	Air	
	Output	Emission	Cl2	0.00049			kg	Air	
	Output	Emission	CO	0.30			kg	Air	
	Output	Emission	CO2	801			kg	Air	
	Output	Emission	Dust	0.29			kg	Air	
	Output	Emission	H2S	0.0028			kg	Air	
	Output	Emission	HCl	0.45			kg	Air	
	Output	Emission	HF	0.0067			kg	Air	
	Output	Emission	Hydrocarbons	2.6			kg	Air	
	Output	Emission	N2O	0.0014			kg	Air	
	Output	Emission	NH3	0.021			kg	Air	
	Output	Emission	Nitrogen	2.5			kg	Air	
	Output	Emission	NOx	1.1			kg	Air	
	Output	Emission	PH3	0.00052			kg	Air	
	Output	Emission	SO2	2			kg	Air	
	Output	Product	Aluminium ingot	1000			kg	Technosphere	
	Output	Residue	Ball mill dust	64.3			kg	Technosphere	
	Output	Residue	Dirt	1.9			kg	Technosphere	
	Output	Residue	Filter dust	13.0			kg	Technosphere	
	Output	Residue	Refractory waste	2.1			kg	Technosphere	
	Output	Residue	Solid waste, unspecified	3.4			kg	Technosphere	
	Output	Residue	Stones	4.3			kg	Technosphere	
	Output	Residue	Waste filter material	0.005			kg	Technosphere	
	Output	Residue	Waste oil	2.7			kg	Technosphere	
	Output	Residue	Waste rubber	24.3			kg	Technosphere	
	Output	Residue	Waste sediment	3.4			kg	Technosphere	

About Inventory

Publication	Environmental Profile Report for the European Aluminium Industry, European Aluminium Association, April 2000 -- Data documented by: Maria Erixon, IMI, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 8 May 2002 --
Intended User	LCA-practitioners.
General Purpose	The European Aluminium Association (EAA) aims to contribute to further environmental improvements in aluminium products in a life cycle concept.
Detailed Purpose	The purpose with the Environmental Profile Report 2000 is to provide LCA-practitioners with detailed and up-to-date information representing the aluminium industry activities in Europe. The purposes with formatting the Environmental Profile Report 2000 for the European Aluminium Industry to the data documentation format SPINE, according to the data documentation criteria applied at Centre for environmental assessment of Product and Material systems (CPM) are: - CPM and European Aluminium Association (EAA) are anxious to provide life cycle assessment (LCA) practitioners with accurate and up to date environmental data for aluminium production. - EAA is interested in the SPINE formatting procedure and result, as the format is a base for (and therefor somewhat similar to) the new Technical Specification in ISO, ISO 14048, regarding LCA data documentation format. - EAA is interested in the CPM data quality control and documentation criteria.
Commissioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Practitioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Reviewer	Dr. Ian Boustead, - 2 Black Cottages West Grinstead, Horsham GB-West Sussex RH13 7BD

Applicability	--- SPECIFIC INFORMATION FOR THIS DATA SET --- RECYCLING OF USED ALUMINIUM This recycling model has has been prepared through a survey of aluminium refiners carried out in 1998, with an estimated coverage of 53%. The survey specifically covered secondary refiners of various sizes, ranging in output from <5 000 tpa to major facilities with production in excess of 50 000 tpa. The survey took into account the process technology, feedstock and products, along with the input and output of the various processes. Due to the individual nature of most secondary refining plants it is not possible to publish process-specific data without the risk of exposing commercially sensitive information, because a given site usually has a unique mix of feedstock, products and process technology. For most scrap types there are several viable processing routes, which may be taken in order to meet specific company requirements. For a given scrap, each process route will have advantages and disadvantages. For example, one process route may produce higher metal yields, but at the cost of reduced flexibility, e.g. in the range of feedstock that could be used, higher investment in equipment or additional environmental controls. The aluminium refiners therefore actually make a case-by-case selection, depending on the type of scrap, through a range of pre-treatment, preparation and melting technologies, in order to maximise the metal value and to optimise the environmental aspects. As a result of this inherent variability in scrap processing for recycling, the aluminium recycling model developed here is only indicative, and this should be borne in mind if it is used to describe the recycling of any particular product. Any LCA-study on aluminium recycling would need to check carefully how well this fits with the particular aluminium product or process involved, in order to avoid misinterpretations or incorrect conclusions. ALUMINIUM RE-MELTING VERSUS PRIMARY ALUMINIUM PRODUCTION Aluminium re-melting requires much less energy than the primary aluminium production from its ore. A clear-cut comparision is not possible because the energy used in re-melting is predominantly thermal while being electrical in the electrolysis. However, aluminium re-melting saves raw materials and energy, and also reduces demands on landfill sites. --- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- RECOMMENDATIONS BY EAA WHEN USING THE DATA The data provided by the EAA members for their own process steps are the most up-to-date average data available for these processes, and it is recommended that they be used for LCA purposes. Older literature data should be disregarded, as it may no longer be representative due to technological improvements, progress in operating performance, changes with regard to raw materials or waste treatment, etc. To complete the product system inventory, data - on the production of consumer products, from semi-fabricated aluminium, - on the performance of consumer products in the use phase, and - on the recovery of scrap prior to remelting at the end of the product’s useful life should be acquired. EAA recommend that these data be used in LCA studies in accordance with methodologies within the framework of the international standards in the ISO 14040-series. RELATED DATA SETS IN SPINE DATA FORMAT The data presented in the Environmental Profile Report is reformatted in to the SPINE format and structured according to the SPINE concept in as many separate activities (sub-systems) as possible. The system scope for the study as a whole is primary aluminium production, semi-finished aluminium production, and recycling. The SPINE formatting resulted in 7 activities. These activities are all published in the SPINE@CPM database. The production and recycling step are intended to be used together. For example, to obtain a cradle to gate-system for rolled aluminium sheet, the activity Primary aluminium production should be connected to the activity Production of rolled aluminium sheet. A recycling step (Aluminium recycling by refiners) could also be connected to such a system, depending on the scope. -- List of activities formatted in the SPINE-format, published in SPINE@CPM -- Primary aluminium production 1. Primary aluminium production Semi-finished aluminium product fabrication 2. Production of rolled aluminium sheet 3. Production of extruded aluminium profiles 4. Production of 0,02-0,2 mm single-rolled aluminium foil 5. Production of 0,005-0,02 mm double-rolled aluminium foil Recycling 6. Re-melting of aluminium scrap 7. Aluminium recycling by refiners

	Please note: The recycling process 6. Re-melting of aluminium scrap is included in the semi-finished aluminium product fabrication, i.e. activities 2-5. When designing a product system with the activities above where recycled aluminium is regarded, the activity Aluminium recycling by refiners should be used. The Re-melting of aluminium activity is only a specification if the user is specifically interested in this process step. RECYCLING RATES FOR ALUMINIUM PRODUCTS AFTER USE After use, aluminium products are a valuable re-usable resource. The European recycling rates for end products are currently around 95% for the automotive sector and 85% for the building sector. IMPROVEMENTS IN THE ENVIRONMENTAL PERFORMANCE OF ALUMINIUM PRODUCTS AND PROCESSES OVER THE PAST FEW YEARS Over the past few years EAA has achieved major improvements in the environmental performance of its production processes by means of the following: - improvement on existing technology - development and introduction of new technology and operations - increased recycling of all materials in the production process. Examples of major environmental improvements in aluminium products achieved over the past few years include: - weight reduction by downgauging in the packaging sector - energy savings through weight reduction and subsequent fuel reduction in the transport sector - reduction of maintenance in the building sector The previous Ecological Profile Report from EAA was published in 1996.
About Data	--- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- PRECISION According to EAA, the environmental data figures in the inventory table are usually accurate to a precision of 5%. DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION The electricity supply systems and fuel production and use (transport energy and emission data) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250' and EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems. All emissions connected with total fuel consumption (i.e. production and combustion of oil, gas or coal) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250', table 16.9. Emissions from combustion only, i.e. excluding the contribution of the production of the fuel, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of production and combustion of fuels in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, in view of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors. REVIEW OUTSPOKE Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, April 2000, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. Ian Bousteds' review comments on the Environmental Profile Report for the European Aluminium Industry, April 2000: ''...I have received the detailed calculations on which this present environmental report is based. All of the queries that I raised after working through these reports were answered satisfactory.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Good-quality data were supplied by the EAA member companies, and the number of companies participating provides good coverage of the various processes, meaning that the results can be regarded as representative of the industryas a whole for the production of primary aluminium and subsequent conversion processes.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Because of the very fragmented nature of the recycling industry and wide variations in practices, it is recognised that the data presented for this sector of the industry can only be regarded as indicative. Nevertheless it is helpful to have such information from an authorative source.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000
Notes	REVIEWER Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. See AboutData for review comments.

	GENERAL TECHNICAL INFORMATION ABOUT SECONDARY SMELTING FURNANCES Below some further information about the different types of furnaces and areas of application for secondary smelting furnances used in aluminium recycling. Furnance type: REVERBERATORY Variations: Standard, Side Well and Sloping Hearth STANDARD Principal application: Melting larger volumes of clean scrap and primary feedstock Advantages: Large metal capacity (<=100t), Few restriction on feedstock sizes, Lower salt slag use Disadvantages: Lower thermal efficiency, Restricted feedstock types Comments: High yields due to quality of feedstock, Molten metal pumps sometimes used SIDE WELL Principal application: Melting larger volumes of clean scrap and primary feedstock, Enables efficient recovery of some finer feedstocks Advantages: Large metal capacity, Wider range on feedstock possible, Normally no salt slag Disadvantages: Lower thermal efficiency Comments: High yields due to quality of feedstock, Molten metal pumps sometimes used SLOPING HEARTH Principal application: Separation of aluminium from higher melting point metal contamination (i.e. iron/steel) Advantages: Very efficient at removing high melting point contaminants Disadvantages: Lower thermal efficiency Comments: Sometimes incorporated into other furnance types, Yield dependent on level of contamination Furnance type: ROTARY Variations: Fixed Axis, Tilting FIXED AXIS Principal application: Recycling a wide range of feedstocks Advantages: No feedstock restrictions, Good thermal efficiency, Efficient de-magging, No skimmings produced, Large chargevolumes possible (<50t) Disadvantages: Relatively high usage of salt flux, Feedstock size may be restricted Comments: Resultant salt slags can be reprocessed TILTING Principal application: Recycling a wide range of feedstocks Advantages: No feedstock restrictions, Good thermal efficiency, Efficient de-magging, No skimmings produced, Large chargevolumes possible (<50t) and lower use of salt flux than ''Fixed Axis'' Disadvantages: Feedstock size may be restricted Comments: Tends to be used for lower scrap grades Furnance type: INDUCTION Variations: Coreless, Channel CORELESS Principal application: Melting of cleaner scrap or primary feedstock Advantages: High yields obtained, No combustion gases, No salt flux required, Flexible use (batch and continous processing possible) Disadvantages: Relatively small load (<10t), Restricted feedstock type, Feedstock size may be restricted Comments: - CHANNEL Principal application: Melting of cleaner scrap or primary feedstock Advantages: High yields obtained, No combustion gases, No salt flux required Disadvantages: Relatively small load (<20-25t), Restricted feedstock type, Feedstock size may be restricted Comments: -

SPINE LCI dataset: Anaerobic digestion of biological household waste. ESA-DBP

Administrative	
Finished	Y
Date Completed	2006-2007

Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Anaerobic digestion of biological household waste. ESA-DBP
Functional Unit	1 ton of biological household waste
Functional Unit Explanation	The functional unit is 1 ton of dry substance biological household waste.
Process Type	Gate to gate
Site	
Sector	Waste treatment
Owner	
Technical system description	Biogas is produced when biological material is decomposed by methane producing bacteria during anaerobic conditions. These processes work in the temperature interval of 10 to 70 degrees Celsius. The most common process temperatures at biogas plants lies within the mesophilic range (around 35 degrees Celsius) or the thermophilic range (around 55 degrees Celsius) since the turnover of the bacteria is high at these temperatures. Thermophilic processes have become more and more common, since less volume for the anaerobic chamber is needed at higher temperatures. Wet processes are most abundant, but anaerobic digestion can also take place in dry processes. The process can be design in different ways depending on the type of substrate. One anaerobic digestion chamber is used in one-step processes, in two-steps processes chambers in series are used. When digesting sewage sludge different filters and carriers for microorganisms are used to optimize the process. Translated excerpts from the report (see 'Publication'): '' The biogas system consists of the digestion plants, waste deliveries and use of products. The waste transport to the plant is executed by waste collection vehicles driven with diesel or biogas. It is assumed that the cars go empty on the way back i.e. both there and back is accounted for. At the plant both biogas, solid digestion rest and liquid digestion rest are produced. Most of the biogas is sold to Trollhättan city for upgrading to vehicle gas. Some of the gas is distributed to the plants owngas net, from where the gas is sold to costumers for heating. Moreover some of the gas is used directly at the plant , or is burned as spill-over. The solid digestion rest is used to cover landfills at the plant, while the liquid digestion rest is used as fertilizer in agriculture. When the waste is digested it cannot be used for electricity- and heatproduction, as the case in the incineration alternative. To be able to compare the two different alternatives on an even basis emissions from equivalent production of electricity and heat from the Gothenburg District Heating plant are included.'' Processes included in the biogas system: - Anaerobic digestion plant (electricity from wind and water) - Upgrading and compressing - End use, light vehicles - End use, heacy vehicles - Waste transport with waste collection vehicle driven on diesel - Waste transport with waste collection vehicle driven on biogas - Combustion of biogas in a combustor belonging to the plant - Burning of spill-over biogas - Transport of and spreading of liquid digestion rest - District heating production - Electricity production, Swedish electricity mix Processes not included in the biogas system: - Leakage water - Solid digestion rest for covering of landfills - Methane leakage This process is included in the system described in: Ljungkvist H, 2008, Miljö- och samhällsekonomisk analys av behandling av biologiskt avfall. Environmental Systems Analysis report 2008:1, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2008--1.pdf Other processes in the CPM Database also included in the above publication: 'Incineration of of biological household waste. ESA-DBP'

System Boundaries

Nature Boundary	Not applicable.

Time Boundary	The documentor makes a qualified guess that the data was produced in the years 2006-2007, based on information in the report.
Geographical Boundary	The anaerobic digestion plant is located in Heljestorp, Västra Götaland, Sweden. Translated excerpts from the report (see 'Publication'): ''Waste transported from Trollhättan travelles 10 km one way with biogasdriven waste collection vehicles that need 7,3 m3 biogas per 10 km. The truck max load is assumed to be 8 tons.'' ''Waste from other municipalities (than Trollhättan) is assumed to travel in average 40 km to the plant, with dieseltrucks needing 3,5 liter diesel per 10 km. The truck max load is assumed to be 8 tons.'' ''The liquid digestion rest is transported 27,5 km one way to the agriculture and is spread in growing crop. The nitrogen evaporation is 5 percent.''
Other Boundaries	Translated excerpts from the report (see 'Publication'): '' The biogas system consists of the digestion plants, waste deliveries and use of products. The waste transport to the plant is executed by waste collection vehicles driven with diesel or biogas. It is assumed that the cars go empty on the way back i.e. both there and back is accounted for. At the plant both biogas, solid digestion rest and liquid digestion rest are produced. Most of the biogas is sold to Trollhättan city for upgrading to vehicle gas. Some of the gas is distributed to the plants owngas net, from where the gas is sold to costumers for heating. Moreover some of the gas is used directly at the plant , or is burned as spill-over. The solid digestion rest is used to cover landfills at the plant, while the liquid digestion rest is used as fertilizer in agriculture. When the waste is digested it cannot be used for electricity- and heatproduction, as the case in the incineration alternative. To be able to compare the two different alternatives on an even basis emissions from equivalent production of electricity and heat from the Gothenburg District Heating plant are included.'' Processes included in the biogas system: - Anaerobic digestion plant (electricity from wind and water) - Upgrading and compressing - End use, light vehicles - End use, heacy vehicles - Waste transport with waste collection vehicle driven on diesel - Waste transport with waste collection vehicle driven on biogas - Combustion of biogas in a combustor belonging to the plant - Burning of spill-over biogas - Transport of and spreading of liquid digestion rest - District heating production - Electricity production, Swedish electricity mix Processes not included in the biogas system: - Leakage water - Solid digestion rest for covering of landfills - Methane leakage ''The solid digestion rest is not included in the system because emissions from this are mixed with emissions to air and water from landfills.'' ''Storage of liquid digestion rest is excluded from the system.'' ''Usage of chemicals for maintenance of the plant is excluded from the system.'' ''The raw biogas from the plant is assumed to consist of 70 % methane.'' ''Leakage of methane when upgrading and compressing is assumed to be 2 %.''
Allocations	Not applicable.
Systems Expansions	Translated excerpts from the report (see 'Publication'): ''When the waste is digested it cannot be used for electricity- and heatproduction, as the case in the incineration alternative. To be able to compare the two different alternatives on an even basis emissions from equivalent production of electricity and heat from the Gothenburg District Heating plant are included.''

Flow Data

General Activity QMetaData

Date Conceived	2006-2007
Data Type	Derived, mixed
Represents	See 'Function'.
Method	Not applicable.
Literature Reference	Ljungkvist H, 2008, Miljö- och samhällsekonomisk analys av behandling av biologiskt avfall. Environmental Systems Analysis report 2008:1, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2008--1.pdf

Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Input Product	Biological household waste	1000			kg	Technosphere	Sweden
	Output	Emission	As	1.01			mg	Air	Sweden
	Output	Emission	Cd	0.81			mg	Air	Sweden
	Output	Emission	CH4	1.91			kg	Air	Sweden
	Output	Emission	CO	0.13			kg	Air	Sweden
Notes: From fossil fuels.	Output	Emission	CO2	286			kg	Air	Sweden
	Output	Emission	Cr	6.78			mg	Air	Sweden
	Output	Emission	Cu	47.5			mg	Air	Sweden
	Output	Emission	HC	17			g	Air	Sweden
	Output	Emission	HCl	2.02			g	Air	Sweden
	Output	Emission	HF	105			mg	Air	Sweden
	Output	Emission	Hg	2.02			mg	Air	Sweden
	Output	Emission	N	0.26			kg	Air	Sweden
	Output	Emission	N2O	0.02			kg	Air	Sweden
	Output	Emission	Ni	3.85			mg	Air	Sweden
	Output	Emission	NMVOC	39			g	Air	Sweden
	Output	Emission	NOx	1.44			kg	Air	Sweden
	Output	Emission	Particles	0.09			kg	Air	Sweden
	Output	Emission	Pb	12.1			mg	Air	Sweden
	Output	Emission	S	31			g	Air	Sweden
	Output	Emission	SOx	0.26			kg	Air	Sweden
	Output	Emission	Zn	5.67			mg	Air	Sweden
	Output	Product	Bio fertilizer; total Nitrogen	5257			g	Technosphere	Sweden
	Output	Product	Biogas	4255			MJ	Technosphere	

About Inventory

Publication	Ljungkvist H, 2008, Miljö- och samhällsekonomisk analys av behandling av biologiskt avfall. Environmental Systems Analysis report 2008:1, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2008--1.pdf
Intended User	LCA practitioners and employees at Ragn-Sells.
General Purpose	Master Thesis. Excerpt from the report (see 'Publication'): ''Biogas is a renewable fuel that can be extracted from anaerobic digestion of many different substrates, for example biological household waste. An alternative handling of the waste is to mix it with other wastes and incinerate it in a combined heat and power (CHP) plant. This study uses life cycle assessment to investigate which type of waste handling that is better from an environmental point of view, anaerobic digestion with biogas production or incineration. The results are based on a case study of a biogas production plant owned by the company Ragn-Sells in Vänersborg. The alternative is incineration at a CHP plant in Gothenburg.''
Detailed Purpose	These are the data for the anaerobic digestion process.
Commissioner	
Practitioner	
Reviewer	
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Translated excerpts from the report (see 'Publication'): ''Waste transported from Trollhättan travelles 10 km one way with biogasdriven waste collection vehicles that need 7,3 m3 biogas per 10 km. The truck max load is assumed to be 8 tons.'' ''Waste from other municipalities (than Trollhättan) is assumed to travel in average 40 km to the plant, with dieseltrucks needing 3,5 liter diesel per 10 km. The truck max load is assumed to be 8 tons.'' ''The liquid digestion rest is transported 27,5 km one way to the agriculture and is spread in growing crop. The nitrogen evaporation is 5 percent.'' '' Electricity and heat equivalent to what would be produced if the waste was burnt in a power plant is approximated with Swedish electricity mix and district heating production in Gothenburg.''

	'' Emissions from Swedish electricity production are based on LCA data including emissions from production and maintenance of plants.'' ____ ESA Database Project. Years: 2009-2011. Documentation completed for this data set: YYYY-MM-DD Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA. Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Australia, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Australia, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Australia
Sector	Energyware
Owner	Australia
Technical system description	The generation of electricity with different power generating systems in Australia during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data
General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	108763			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	15766			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	17423			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	2233			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	30			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	3320			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	46781			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	8			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	194324			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version

	- Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Austria, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Austria, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Austria
Sector	Energyware

Owner	Austria
Technical system description	The generation of electricity with different power generating systems in Austria during the year 1998.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	1702			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	3108			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	37164			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	4230			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	838			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	8843			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	55885			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. --- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by:

	Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Belgium, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Belgium, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Belgium
Sector	Energyware
Owner	Belgium
Technical system description	The generation of electricity with different power generating systems in Belgium during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite and sub-bit. coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	1062			GWh	Technosphere	

Represents: Wind	Input	Refined resource	Electricity	11			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	15036			GWh	Technosphere	
Represents: Hard coal, coke oven gas and blas furnace gas	Input	Refined resource	Electricity	16890			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	2580			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage Notes: The value have been corrected after publishing. See Inventory Notes for a description.	Input	Refined resource	Electricity	389			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	46165			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	82133			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998

	New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	--- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 22 October 2001: <<< Changes made by Ann-Christin Pålsson, CPM: The electricity production by hydro power have been corrected from 1497 GWh to 389 GWh according to the original report. The error was identified and reported by Gunnar Mattson, ABB Corporate Research.

SPINE LCI dataset: Biofuel electricity energy system, EPD-version

Administrative	
Finished	Y
Date Completed	1996
Copyright	Bundesamt für Energie, Bern and Vattenfall AB respectively.
Availability	Public

Technical System	
Name	Biofuel electricity energy system, EPD-version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant istself). Electricity distribution and distribution losses are not accounted for.
Process Type	Cradle to grave
Site	Europe Unspecified
Sector	Grid electricity and district heat
Owner	Europe Unspecified
Technical system description	Reported figures are based on a combination of data from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996 and of data from a LCI-study performed at Vattenfall AB, Life-cycle Assessment for Vattenfall's Electricity Generation, 1996 and adapted to the demands of the EPD-guidelines (Environmental Product Declaration guidelines in Sweden). . -- Brief description -- Data about the fuel chain i.e. fuel production and transports of fuel has been acquired from ETH and data about power plant operation has been provided by Vattenfall's study. The main phases inventoried in ETH's fir wood chips chain are: wood growth, forest care, light thinning of young forests and gathering of forest residues, transport by tractor to a nearby forest road, wood chipper, interim storage in containers, transport to combustion plant Data has been aquired from literature and figures concerning consumption of energyware and materials, use of land and water, emissions to air (also radioactive) and water and wastes have been picked out from or calculated based on literature for all phases of the life cycle.

	All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle. -- Detailed description -- Forest growth The trees take CO2 from the air to grow and this has been reported as a negative emission of CO2. Construction of vehicles is included. Forest care Forest care includes construction of roads and bridges, the operation of tree-nurseries, planting, light thinning, clearing up after storms, hunt, protection against noxious animals etc. but only diesel consumption during planting, felling and road maintenance is included as well as area use. Felling Construction and diesel production and consumption of machines are included, from growing tree to forest road. Chipping Diesel production and consumption and construction of chipping machine is included. Transport Transport (22,5 km) with lorry (28 tonnes) from forest road to power plant is included. Power plant Only power plant operation emissions to air and ash amounts have been taken into account as well as fuel consumption. The power plant is a modern CFB (circulating fluidized bed), 9 MW with electro filter. Electric net efficiency has been set to 38% in accordance with stone coal fired plants. Condensing conditions are assumed. The fuel - wood chips (fir) - has an energy content of 4.6 MW/tonne dry substans (16.6 MJ/kg DS, 7.1 MJ/kg 50% humidity) and an ash content of 2% TS. Operation time 4400 h/year. Ashes are assumed to be deposited (no emissions from landfill included). Construction has been approximated with the construction of a 300 kW furnace (5000 h/year, 20 years lifetime). * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries	
Nature Boundary	ETH's study: Used materials and energyware have been followed from extraction and processing of natural resources. Manufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH. Vattenfall's criterion in selecting and aggregating ETH's LCI-results for electricity generation in the UCPTE region has been to make the figures usable as general electricity LCI data in EPDs according to Miljöstyrningsrådets guidelines. Especially parameters (emissions) which have established impact indices - accepted by the EPD system - for one or several environmental impact categories, have been picked out and aggregated as far possible. But also metal and energyware resources have been included. Since ETH claimes that most of the figures regarding metal emissions have an undefined amount of datagaps all metal emissions are aggregated except for a few which are specified separatly since they are reported for most processes in the lifecycle. Metals are reported as elements although they often are part of compounds. Measuring methods often just give the amounts of the different elements found. All hydrocarbons to water are aggregated to one parameter as well as halogenated organics, since no indices exist (that are accepted by the EPD system so far) for characterisation of the individual substances. Vattenfall's study: Only the operation emissions to air of the studied plant and the amounts of ashes generated are included in this set of figures.
Time Boundary	ETH's study: Most background data refer to the period 1990 to 1994. Electricity used during the lifecycle has been assumed to be a mix based on the average

	generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years). All processes, also those conducted in the past, have been assumed to use average technology of the early nineties. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Furnace 20 years Chips containers 15 years Trailer 20 000 h Tyres 2 500 h * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain. Vattenfall's study: The study embodies the lifetime of the studied plant, 40 years, but this has no impact on figures presented here since only figures regarding emissions and generated ashes per MJ fuel has been used.
Geographical Boundary	ETH's study: Figures are based on average lignite power plants in Austria, Germany, Spain, Ex-Jugoslavia, France and Greece. Lignite mining has been studied in the UCPTE since less than 1% is imported. 67% of lignite used in UCPTE is mined in Germany. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain. Vattenfalls study: no geographical boundaries regarding figures used in this study.
Other Boundaries	ETH's study: The buning of wood residues in the forest in connection with felling has not been included. Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. The ETH study comprises figures concerning use of land, usable content in water storages and amount of turbine water which have not been reported here. The two latter have been excluded due to lack of corresponding data in comparable studies. Use of land has been excluded because of ETH's advanced approach. Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the indutrial revolution I Modified human impact larger than other species', low degree of culivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of intererst. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is different from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.)

	ETH specifies about 160 radioactive isotopes emitted to air and water. Radioactive emissions reported here are picked out in accordance with SETAC working group report on data quality and data availability (to be published in 2001). Big accidents occuring seldomly are not included.The threshold is fixes at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world. Vattenfall's study: no other boundaries regarding figures used in this study.
Allocations	ETH:s study: Allocation between the different products of the forest has been conducted according to the volume of the different products. The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle. Vattenfall's study: No allocation has been made, condensing conditions in the power plant is assumed, i.e. generated electricity bears all emissions.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Approximate electricity generation with biofuel in modern power plant in Europe.
Method	The data has been adapted from the Ökoinventare von Energiesystemen, ETH Zürich 1996 concerning biofuel production (aggregation of the LCI results for the modules ''Holzschnitzel Fichte frei Lager'' per tonnes dry substance (0,0166 TJ/tonnes DS), ''Transport LKW 28 t'' per tkm (2 x 22,5 tkm (back and forth)) and ''Infra Feuerung Fichte 300'' per piece (electricity production 108 TJ/lifetime i.e. 300 kW, 5000 h/year, 20 years). Electric efficiency of power plant (condensing conditions assumed) has been set to 38% in accordance with stone coal fired power plants. Data about power plant operation has been taken from Vattenfall's LCA study of a bio-fuelled CFB plant (circulating fluidized bed).
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen Life-cycle Assessment for Vattenfall's Electricity Generation, Summary Report 1996 Vattenfall AB, Britt-Marie Brännström-Norberg, Ulrika Dethlefsen, Roland Johansson, Caroline Setterwall, Sofie Tunbrant
Notes	

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Bauxite	5.90			kg	Ground	
	Input	Natural resource	Chromium in ore	0.472			kg	Ground	
	Input	Natural resource	Copper in ore	0.444			kg	Ground	
Notes: From drillhole	Input	Natural resource	Crude oil	2777			kg	Ground	
Notes: Before processing	Input	Natural resource	Hard coal	293			kg	Ground	
	Input	Natural resource	Iron in ore	200			kg	Ground	
	Input	Natural resource	Lead in ore	1.49			kg	Ground	
Notes: Before extraction	Input	Natural resource	Lignite	126			kg	Ground	
	Input	Natural resource	Limestone	85.7			kg	Ground	
	Input	Natural resource	Manganese in ore	0.377			kg	Ground	

Notes: Summation of ''Erdoelgas'' (40,9 MJ/Nm3), ''Grubengas'' (35,9 MJ/kg) and ''Rohgas'' (35 MJ/Nm3). Expressed as Natural gas with lower heating value (35 MJ/Nm3). The heating values are acquired from table III 8.1 in the methodology chapter in Ökoinventare von Energiesystemen, ETH, Zürich 1996	Input	Natural resource	Natural gas	285			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.139			kg	Ground	
	Input	Natural resource	Palladium in ore	9.53E-07			kg	Ground	
	Input	Natural resource	Platinum in ore	1.12E-06			kg	Ground	
	Input	Natural resource	Rhodium in ore	1.02E-06			kg	Ground	
	Input	Natural resource	Rock salt	21.4			kg	Ground	
	Input	Natural resource	Uranium in ore	0.00866			kg	Ground	
	Input	Natural resource	Water	6.58E+04			kg	Ground	
	Input	Natural resource	Wood	174386			kg	Ground	
	Input	Natural resource	Zinc in ore	0.0286			kg	Ground	
Notes: Summation of Ag, Sn, Rh, Mo, Co.	Input	Refined resource	Metals	1.35E-02			kg	Technosphere	
Notes: C3H4Cl2	Output	Emission	1,2-Dichloroethane	5.43E-05			kg	Air	
	Output	Emission	Ag-110m	0.0243			kBq	Water	
	Output	Emission	Ag-110m	3.57E-06			kBq	Air	
	Output	Emission	Am-241	0.00879			kBq	Water	
	Output	Emission	Am-241	6.67E-05			kBq	Air	
Notes: BOD5	Output	Emission	BOD	4.02E-02			kg	Water	
	Output	Emission	C-14	0.445			kBq	Water	
	Output	Emission	C-14	5.38			kBq	Air	
	Output	Emission	C-60	1.51E-04			kBq	Air	
	Output	Emission	Cd	1.23E-03			kg	Water	
	Output	Emission	Cd	2.49E-04			kg	Air	
	Output	Emission	Cd	4.61E-06			kg	Ground	
Notes: CCl3F	Output	Emission	CFC-11	2.74E-06			kg	Air	
Notes: C2Cl2F4	Output	Emission	CFC-114	7.24E-05			kg	Air	
	Output	Emission	CFC-12	5.89E-07			kg	Air	
	Output	Emission	CFC-13	3.70E-07			kg	Air	
	Output	Emission	Cm alpha	0.0117			kBq	Water	
	Output	Emission	Cm alpha	1.06E-04			kBq	Air	
	Output	Emission	Cm-244	3.18E-09			kBq	Air	
	Output	Emission	CN-	1.40E-03			kg	Water	
Notes: Cyanied ion	Output	Emission	CN-	5.85E-05			kg	Air	
	Output	Emission	CO	187.89			kg	Air	
	Output	Emission	CO2	8964			kg	Air	
	Output	Emission	Co-58	0.0398			kBq	Water	
	Output	Emission	Co-58	1.01E-04			kBq	Air	
	Output	Emission	Co-60	1.949			kBq	Water	
	Output	Emission	COD	0.554			kg	Water	
	Output	Emission	Cr	3.18E-04			kg	Air	
	Output	Emission	Cr	6.53E-03			kg	Water	
	Output	Emission	Cr	8.05E-04			kg	Ground	
	Output	Emission	Cs-134	0.450			kBq	Water	
	Output	Emission	Cs-134	2.54E-03			kBq	Air	
	Output	Emission	Cs-137	0.00489			kBq	Air	
	Output	Emission	Cs-137	4.147			kBq	Water	
	Output	Emission	Dichloromethane	1.49E-06			kg	Air	
	Output	Emission	Dioxin (TCDD)	672			ng	Air	
	Output	Emission	Dissolved solids	0.193			kg	Water	
	Output	Emission	H-1301	1.08E-03			kg	Air	
	Output	Emission	H2S	0.0113			kg	Air	

	Output	Emission	H-3	1.32E+04			kBq	Water	
	Output	Emission	H-3	55.3			kBq	Air	
Notes: Summation of AOX, 1,1,1-trichloroethane, chlorobenzene, dichloromonofluoromethane, ethylene dichloride, hexachlororethane, metylenchloride, tetrachloroethylene, trichloroethylene, trichloromethane.	Output	Emission	Halogenated organics	1.75E-03			kg	Water	
Notes: Summation of Cl-, F- and I-.	Output	Emission	Halogenids	9.40E+01			kg	Water	
Notes: Summation of I and Br.	Output	Emission	Halogens	9.99E-04			kg	Air	
	Output	Emission	HCFC-21	4.54E-03			kg	Air	
	Output	Emission	HCFC-22	6.72E-07			kg	Air	
	Output	Emission	HCl	0.0957			kg	Air	
Notes: No available index. Same index as NMVOC.	Output	Emission	Hexachlorobenzene	3.59E-09			kg	Air	
	Output	Emission	Hexafluoroethane	6.42E-05			kg	Air	
	Output	Emission	HF	0.0128			kg	Air	
	Output	Emission	HFC-134a	8.49E-16			kg	Air	
	Output	Emission	Hg	1.37E-05			kg	Water	
	Output	Emission	Hg	5.23E-05			kg	Air	
	Output	Emission	Hg	5.23E-07			kg	Ground	
Notes: Summation of acenaphtene, acenaphtylene, alkane, alkene, aromats, benzene, butyl benzyl phtalat, bibutyl p-phtalat, dimethyl p-phtalat, ethylbenzen, volatile hydrocarbons, formaldehyd, glutaraldehyd, hydrocarbons, MTBE (Metyl Tertiary Butyl Eter), phenol, styrol, toluol, triethylenglycol, xylol.	Output	Emission	Hydrocarbons	2.22E-01			kg	Water	
	Output	Emission	I-129	0.0191			kBq	Air	
	Output	Emission	I-129	1.270			kBq	Water	
	Output	Emission	I-131	0.000860			kBq	Water	
	Output	Emission	I-131	0.00220			kBq	Air	
	Output	Emission	I-133	0.000223			kBq	Water	
	Output	Emission	I-133	0.00118			kBq	Air	
	Output	Emission	K-40	0.0115			kBq	Air	
	Output	Emission	K-40	0.0326			kBq	Water	
	Output	Emission	Kr-85	3.28E+05			kBq	Air	
Notes: Summation of the ions of following metals: Ag, Al, Ar, Ba, Be, Cs, Ca, Fe, K, Co, Mg, Mn, Mo, Na, Ni, Ru, Sb, Se, Sn, Sr, Ti, W.	Output	Emission	Metal ions	6.38E+01			kg	Water	
Notes: Summation of Al, As, Ba, Be, Ca, Co, Cu, Fe, K, La, Mg, Mn, Mo, Ni, Pt, Sb, Sc, Se, Sn, Sr, Th, Ti, Tl, U, Zr.	Output	Emission	Metals	1.03E-01			kg	Air	
Notes: Summation of Al, As, Ca, Co, Cu, Fe, Mn, Ni, Sn.	Output	Emission	Metals	1.13E+00			kg	Ground	
	Output	Emission	Methane	13.693			kg	Air	
	Output	Emission	Mn-54	0.299			kBq	Water	
	Output	Emission	Mn-54	3.62E-06			kBq	Air	
	Output	Emission	N	1.53E-04			kg	Ground	
	Output	Emission	N total	0.603			kg	Water	
	Output	Emission	N2O	13.6			kg	Air	
	Output	Emission	NH3	0.00322			kg	Air	
Notes: Summation of acetaldehyd, acetylene, aceton, acrolein, aldehyd, alkane, alkene, aromats, benzaldehyd, benzene, butan, buten, acetic acid, etan, etanol, etene, ethylbenzene, ethylenoxide (C2H4O), formaldehyd, heptan, hexan, metanol, MTBE (Metyl Tertiary Butyl Eter), NMVOC, pentane, phenol, propan, propen, propion aldehyd, propionic acid, styrol,	Output	Emission	NMVOC	4.58E+01			kg	Air	

toluol, xylol.									
	Output	Emission	NO2-	3.55E-04			kg	Water	
	Output	Emission	NO3-	0.221			kg	Water	
Notes: as NO2	Output	Emission	NOx	252			kg	Air	
	Output	Emission	Np-237	0.000561			kBq	Water	
	Output	Emission	Oil	1.00E+01			kg	Water	
	Output	Emission	Oil	7.45E+00			kg	Ground	
	Output	Emission	P	0.00826			kg	Ground	
	Output	Emission	P total	2.47E-04			kg	Air	
	Output	Emission	PAH	1.85E-03			kg	Water	
Notes: Same index as NMVOC.	Output	Emission	PAH	2.97E-04			kg	Air	
	Output	Emission	Particles	29.4			kg	Air	
	Output	Emission	Pb	6.85E-03			kg	Water	
	Output	Emission	Pb	8.60E-05			kg	Ground	
	Output	Emission	Pb	9.38E-03			kg	Air	
	Output	Emission	Pb-210	0.0260			kBq	Water	
	Output	Emission	Pb-210	0.0645			kBq	Air	
Notes: C6HCl5, no available index. Same index as NMVOC.	Output	Emission	Pentachlorobenzene	9.62E-09			kg	Air	
Notes: C6HCl5O, no available index. Same index as NMVOC.	Output	Emission	Pentachlorophenol	1.56E-09			kg	Air	
	Output	Emission	Po-210	0.0260			kBq	Water	
	Output	Emission	Po-210	0.0973			kBq	Air	
	Output	Emission	PO43-	5.63E-02			kg	Water	
	Output	Emission	Pu alpha	0.000212			kBq	Air	
	Output	Emission	Pu alpha	0.0349			kBq	Water	
	Output	Emission	Pu-238	7.91E-09			kBq	Air	
	Output	Emission	Ra-226	0.0769			kBq	Air	
	Output	Emission	Ra-226	175.7			kBq	Water	
Notes: Long-term emissions of Rn-222	Output	Emission	Rn-222	4.71E+05			kBq	Air	
	Output	Emission	Rn-222	5.14E+03			kBq	Air	
	Output	Emission	Ru-106	0.0212			kBq	Air	
	Output	Emission	Ru-106	2.116			kBq	Water	
	Output	Emission	S	0.0966			kg	Ground	
Notes: Includes Tot-S, S-, S in H2S, S in sulphate, S in sulphite	Output	Emission	S total	2.66E+00			kg	Water	
	Output	Emission	Sb-124	0.00634			kBq	Water	
	Output	Emission	Sb-124	9.81E-07			kBq	Air	
	Output	Emission	Sb-125	0.000397			kBq	Water	
	Output	Emission	Sb-125	1.31E-07			kBq	Air	
	Output	Emission	SO2	42.7			kg	Air	
	Output	Emission	Sr-90	0.00349			kBq	Air	
	Output	Emission	Sr-90	4.24E-01			kBq	Water	
	Output	Emission	Suspended solids	7.606			kg	Water	
	Output	Emission	Tc-99	0.222			kBq	Water	
	Output	Emission	Tc-99	1.48E-07			kBq	Air	
	Output	Emission	Tetrachloromethane	1.31E-05			kg	Air	
	Output	Emission	Tetrafluoromethane	0.000578			kg	Air	
	Output	Emission	Th-230	0.0236			kBq	Air	
	Output	Emission	Th-230	6.130			kBq	Water	
	Output	Emission	Th-232	0.00303			kBq	Air	
	Output	Emission	Th-232	0.00609			kBq	Water	
Notes: Summation of dissolved organic carbon, fat acids as C, volatile organic compounds as C, TOC.	Output	Emission	Total organic carbon	7.08E+00			kg	Water	
	Output	Emission	Tributyl tin	1.39E-04			kg	Water	
	Output	Emission	Trichloromethane	1.44E-06			kg	Air	
	Output	Emission	U-234	0.0254			kBq	Air	
	Output	Emission	U-234	0.0525			kBq	Water	
	Output	Emission	U-235	0.00123			kBq	Air	
	Output	Emission	U-235	0.0781			kBq	Water	
	Output	Emission	U-238	0.0337			kBq	Air	
	Output	Emission	U-238	0.133			kBq	Water	
	Output	Emission	V	1.26E-02			kg	Air	
	Output	Emission	V	2.53E-03			kg	Water	

	Output	Emission	Vinyl chloride	8.86E-06			kg	Air	
	Output	Emission	Xe-133	235.6			kBq	Air	
	Output	Emission	Zn	1.21E-02			kg	Water	
	Output	Emission	Zn	2.60E-03			kg	Ground	
	Output	Emission	Zn	5.13E-02			kg	Air	
	Output	Product	Electricity	1			TJ	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) and processing of hazardous waste is included.	Output	Residue	Hazardous waste	2.65E+01			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Highly radioactive waste	1.48E-06			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, no emissions from landfill assumed. Inert waste deposit is waste at landfill that are inert.	Output	Residue	Inert waste deposit	6.24E+02			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Low radioactive waste	5.66E-04			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Medium and low radioactive waste	1.81E-05			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from landfill. Reactive waste deposit is waste at landfill that is still reactive.	Output	Residue	Reactive waste deposit	3.22E+03			kg	Technosphere	
Notes: Internal flow! Infrastructure of spreading vehicles and emissions are included. Land farming is a treatment of organic sludge, the sludge is spread on a piece of land and left to degrade. Sometimes plants are grown on the land, but those plants are destroyed.	Output	Residue	Waste in land farming	1.70E+01			kg	Technosphere	
Notes: Summation of ''Erdoelgas'' (40,9 MJ/Nm3), ''Grubengas'' (35,9 MJ/kg) and ''Rohgas'' (35 MJ/Nm3). Expressed as Natural gas with lower heating value (35 MJ/Nm3). The heating values are acquired from table III 8.1 in the methodology chapter in the Ökoinventare von Energiesystemen, ETH, Zürich 1996	Output	Residue	Waste to incineration	3.46E+00			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www.energieforschung.ch. Life-cycle Assessment for Vattenfall's Electricity Generation, Summary Report, B-M Brännström-Norberg et al, 1996 -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original studies of ETH and Va
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their life cycles. The results can be used in life cycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans. Vattenfall's purpose with LCA for their electricity generation was to provide customers with data about the environmental impact of the electricity they buy, to create a basis for comparisons

	between energy systems and for decisions about future energy systems Vattenfalls purpose - as a commissioner of putting ETH:s data (and in this case also Vattenfall's data) into Spine format with metadata - is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines. Data is supposed to be used together with IEA statistics about electricity generation mixes in the OECD countries/regions.
Detailed Purpose	ETH:s aim was to describe the average situation in Switzerland concerning heat generation with different kinds of wood fuel. With the help of assumptions and simplifications following phases of the life cycle are described: forestry, felling (light thinning), chipping, transports, storage and furnace. (In this set of figures furnac operation is excluded and replaced by a power plant from Vattenfall's LCA). Vattenfall's aim was to describe the environmental impact of biofuel-based electricity generation. A specific plant was analysed concerning gathering of forest residues, chipping, transports, power plant construction, operation and maintenance and demolition and the handling of ashes. (Here, in this set of figures, only the operation phase of plant has been included.)
Commissioner	BEW, PSEL, Vattenfall - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft, Bern, Switzerland Vattenfall AB, Stockholm, Sweden .
Practitioner	Rolf Frischknecht et al, B-M Brännström-Norberg et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen Vattenfall AB .
Reviewer	None, see further under notes -
Applicability	Data reported here is supposed to be a approximation of bio-fuelled (wood chips from light thinning) elctricity generation in CFB plants in Europe. This set of data is aggregated and documented in accordance with the Swedish EPD-guidelines to be used in combination with IEA statistics concerning electricity generation mixes in OECD countries and regions together with other datasets - based on the ETH study - describing other power generation systems. The EPD-adapted power generation systems in Spine format are named as follows: Fuel gas electricity energy system, EPD-version Biofuel electricity energy system, EPD-version Hydro electricity energy system, EPD-version Lignite electricity energy system, EPD-version Nuclear electricity energy system, EPD-version Stone coal electricity energy system, EPD-version Wind electricity energy system, EPD-version IEA statistics for generation mixes 1998 exist in Spine format for the following 30 countries/regions: OECD total OECD North America OECD Pacific OECD Europe European Union Australia Austria Belgium Canada Czech Rpublic Denmark Finland France Germany Greece Hungary Iceland Ireland Italy Japan Korea Luxembourg Mexico Netherlands New Zealand Norway Poland Portugal Spain Sweden Switzerland Turkey United Kingdom United States

About Data	ETH's study: The reliability of data describing the felling process is quite good but is only valid for light thinning. Since smaller plants need more construction material per energyware produced than larger plants the construction phase of power plant is overestimated. On the other hand power plants are more complicated and need more material than heating-plants. I.e. the construction is a very rough approximation but the environmental impact is probably overestimated. Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided. Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). Vattenfalls's study: Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high. For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of ETH:s data and metadata has been: Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. The technical committee of the Swedish Environmental Management Council - approval of method and aggregation of parameters Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the überarbeitung, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut Vattenfall's LCA has been reviewed by Tomas Ekvall, Chalmers Industriteknik and Lars-Gunnar Lindfors, IVL. --- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 6 June 2001: <<< Changes made by Ann-Christin Pålsson, CPM based on discussions with Caroline Setterwall, Vattenfall AB. Comments: The following changes has been made in the nomenclature for in- and outflows: Mangane in ore -> changed to: Manganese in ore CH4 -> changed to: Methane (to be in accordance with the nomenclature specified in CPM report 2000:2) CN -> changed to: CN- Stone coal -> changed to: Hard coal (to be in accordance with the nomenclature specified in CPM report 2000:2) Other metals -> changed to: Metals Explanations of nomenclature (inserted in Notes for the specific flows): - CN- is Cyanide ion - Reactive waste deposit is waste at landfill that is still reactive. - Inert waste deposit is waste at landfill that are inert. Additional clarifications: - Note that the flows of waste in the table of in- and outflows are internal flows, i.e. they do NOT cross the system boundaries. All waste handling processes is included in the study with respect to use of resources and emissions. - Radioactive waste is accounted for in cubic metres. The product specific requirements for electricity and district heating generation (PSR 1998:1) in the Swedish EPD system states that waste shall be accounted for in gram. However, no conversion factors were given in the study. There are also no general conversion factors that are commonly used.

SPINE LCI dataset: Biogas from household waste, cradle-to-gate, no allocation - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Biogas from household waste, cradle-to-gate, no allocation - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of biogas from household waste
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of Biogas from household waste valid for southern Sweden. The following process are covered: - Collection of the waste - Anaerobic digestion of the waste - Transport and distribution of digestate. All electricity input in the production is Swedish grid mix. Fuel used at the biogas plant for heating are biogas from the plant it self. Allocation is made based on energy content (only case showed in Miljöfaktaboken, since this allocation method is preferred by the Renewable Energy Directive), however a case with system expansion is made in Börjesson et al. which also has been published in the f3 database. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included. Impacts from production buildings and infrastructure are not included.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Southern Sweden.
Other Boundaries	
Allocations	The outputs from the anaerobic digestion are biogas and digestate. Emissions and primary energy demand are all allocated to the biogas. 100 % of the process outputs are thus allocated to the biogas.
Systems Expansions	No.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	Approximate electricity generation with biofuel in modern power plant in Europe.
Method	Literature studies
Literature Reference	Gode, J. et al., 2011, Miljöfaktaboken 2011, Uppskattade emissionsfaktorer för bränslen, el, värme och transporter, Värmeforsk Data in Gode et al. Are based on: Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH. Bu
Notes	

Flow Table and Specific Meta Data									
QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Only energy use, not the energy embedded in the product. Börjesson is not stating what different energy carriers that are included in the primary energy. There is no primary energy factor given.	Input	Resource	Primary energy	0.28			MJ	Ground	
	Output	Emission	Carbon dioxide (fossil)	0.0087			kg	Air	
	Output	Emission	Carbon monoxide	0			kg	Air	
Notes: Methane emissions can vary extensively between sites. These are average data for southern Sweden.	Output	Emission	Methane (biogenic)	0.000108			kg	Air	
	Output	Emission	Nitrogen oxides	0.0000725			kg	Air	
	Output	Emission	Nitrous oxide	0			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	0.0000017			kg	Air	
	Output	Emission	Particles (unspecified)	0.0000015			kg	Air	
	Output	Emission	Sulfur dioxide	0.0000019			kg	Air	
	Output	Product	Biogas from household waste	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Biogas from household waste, cradle-to-gate, system expansion, impact categories only - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System

Name	Biogas from household waste, cradle-to-gate, system expansion, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of biogas from household waste
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of Biogas from household waste valid for southern Sweden. The following processes are covered: - Collection of the waste - Anaerobic digestion of the waste - Transport and distribution of digestate. All electricity input in the production is Swedish grid mix. Fuel used at the biogas plant for heating are biogas from the plant it self. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included. Impacts from production buildings and infrastructure are not included. Data in Börjesson et al. are only published as impact categories and not as emissions except for particles.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Southern Sweden.
Other Boundaries	
Allocations	No.
Systems Expansions	1 kg nitrogen in the original raw material is replacing 0.7 kg mineral fertilizer nitrogen (equivalent of nitrogen accessible to plants including losses in the handling of digestate) and 1 kg phosphorus and potassium, respectively, in the digestate is rep

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	Approximate electricity generation with biofuel in modern power plant in Europe.
Method	Raw material: General – Processed data – Literature studies Transformation: Mainly general – Existing & Preliminary studies Reference: table 1
Literature Reference	Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH.
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Not mentioned in Börjesson	Input	Resource	Primary energy	0			MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. Table 10	Output	Emission	Acidification (AP)	0.000061			kg	Air	
Notes: Given as kg PO4-eq combined emissions. Table 8	Output	Emission	Eutrophication (EP)	0.000028			kg	Air	
Notes: Given as kg CO2-eq combined emissions. Table 7	Output	Emission	Global warming (GWP)	-0.0023			kg	Air	
Notes: Table 12	Output	Emission	Particles (unspecified)	-0.000004			kg	Air	
Notes: Given as kg ethene-eq combined emissions. Table 11	Output	Emission	Photo-oxidant formation (POCP)	0.0000006			kg	Air	

	Output	Product	Biogas from household waste	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Biogas from industrial waste, cradle-to-gate, no allocation - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Biogas from industrial waste, cradle-to-gate, no allocation - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of Biogas from industrial waste
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of Biogas from industrial waste valid for southern Sweden. The following process are covered: - Collection of the waste - Anaerobic digestion of the waste - Transport and distribution of digestate. All electricity input in the production is Swedish grid mix. Fuel used at the biogas plant for heating are biogas from the plant it self. Allocation is made based on energy content (only case showed in Miljöfaktaboken, since this allocation method is preferred by the Renewable Energy Directive), however a case with system expansion is made in Börjesson et al. which also has been published in the f3 database. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included.

	Impacts from production buildings and infrastructure are not included.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Southern Sweden.
Other Boundaries	
Allocations	The outputs from the anaerobic digestion are biogas and digestate. Emissions and primary energy demand are all allocated to the biogas. 100 % of the process outputs are thus allocated to the biogas.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	Approximate electricity generation with biofuel in modern power plant in Europe.
Method	Literature studies
Literature Reference	Gode, J. et al., 2011, Miljöfaktaboken 2011, Uppskattade emissionsfaktorer för bränslen, el, värme och transporter, Värmeforsk Data in Gode et al. Are based on: Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH. Bu
Notes	

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Only energy use, not the energy embedded in the product. Börjesson is not stating what different energy carriers that are included in the primary energy. There is no primary energy factor given.	Input	Resource	Primary energy	0.28			MJ	Ground	
	Output	Emission	Carbon dioxide (fossil)	0.0058			kg	Air	
	Output	Emission	Carbon monoxide	0			kg	Air	
Notes: Methane emissions can vary extensively between sites.	Output	Emission	Methane (biogenic)	0.000108			kg	Air	
	Output	Emission	Nitrogen oxides	0.0000429			kg	Air	
	Output	Emission	Nitrous oxide	0			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	0.0000016			kg	Air	
	Output	Emission	Particles (unspecified)	0.0000011			kg	Air	
	Output	Emission	Sulfur dioxide	0.0000021			kg	Air	
	Output	Product	Biogas from industrial waste	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).

Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Biogas from industrial waste, cradle-to-gate, system expansion, impact categories only - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Biogas from industrial waste, cradle-to-gate, system expansion, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of biogas from industrial waste
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of Biogas from industrial waste valid for southern Sweden. The following process are covered: - Collection of the waste - Anaerobic digestion of the waste - Transport and distribution of digestate. All electricity input in the production is Swedish grid mix. Fuel used at the biogas plant for heating are biogas from the plant it self. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included. Impacts from production of buildings and infrastructure are not included. Data in Börjesson et al. are only published as impact categories and not as emissions except for particles.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Southern Sweden.
Other Boundaries	
Allocations	No.
Systems Expansions	1 kg nitrogen in the original raw material is replacing 0.7 kg mineral fertilizer nitrogen (equivalent of nitrogen accessible to plants including losses in the handling of digestate) and 1 kg phosphorus and potassium, respectively, in the digestate is replacing 1 kg phosphorus and potassium, respectively, in mineral fertilizer. Reference: table 2.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	Approximate electricity generation with biofuel in modern power plant in Europe.
Method	Raw material: General – Processed data – Literature studies Transformation: Mainly general – Existing & Preliminary studies Reference: table 1
Literature Reference	Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH.
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Not mentioned in Börjesson	Input	Resource	Primary energy	0			MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. Table 10	Output	Emission	Acidification (AP)	0.000129			kg	Air	
Notes: Given as kg PO4-eq combined emissions. Table 8	Output	Emission	Eutrophication (EP)	0.000063			kg	Air	
Notes: Given as kg CO2-eq combined emissions. Table 7	Output	Emission	Global warming (GWP)	-0.0158			kg	Air	
Notes: Table 12	Output	Emission	Particles (unspecified)	-0.0000088			kg	Air	
Notes: Given as kg ethene-eq combined emissions. Table 11	Output	Emission	Photo-oxidant formation (POCP)	-0.0000002			kg	Air	
	Output	Product	Biogas from industrial waste	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Biogas from sewage sludge, cradle-to-gate, no allocation - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30

Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System

Name	Biogas from sewage sludge, cradle-to-gate, no allocation - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of biogas from sewage sludge
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of Biogas from sewage sludge valid for Sweden. The following process is covered: - upgrading (water scrubber technique) and purification of raw gas at the sewage treatment plant. Anaerobic digestion, digestate use and treatment and additional methane leakage are not included since these processes are inherent parts of the waste water treatment in Sweden. All electricity input in the production is Swedish grid mix. The study is based on the technology of the Käppala sewage treatment plant (Swedish state-of-the-art). A case with system expansions is made in Palm and Ek which also has been published in the f3 database.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Southern Sweden.
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	Approximate electricity generation with biofuel in modern power plant in Europe.
Method	Literature studies
Literature Reference	Gode, J. et al., 2011, Miljöfaktaboken 2011, Uppskattade emissionsfaktorer för bränslen, el, värme och transporter, Värmeforsk Data in Gode et al. are based on: Palm, D. and Ek, M., 2010, Livscykelanalys av biogas från avloppsreningsverksslam, Report nr
Notes	

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Only energy use, not the energy embedded in the product. Börjesson is not stating what different energy carriers that are included in the primary energy. There is no primary energy factor given.	Input	Resource	Primary energy	0.151			MJ	Ground	

	Output	Emission	Carbon dioxide (fossil)	0.000719			kg	Air	
	Output	Emission	Carbon monoxide	0.00000144			kg	Air	
Notes: Methane emissions can vary extensively between sites.	Output	Emission	Methane (biogenic)	0.000104			kg	Air	
	Output	Emission	Nitrogen oxides	0.00000144			kg	Air	
	Output	Emission	Nitrous oxide	0			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	0.000000216			kg	Air	
	Output	Emission	Particles (unspecified)	0.000000216			kg	Air	
	Output	Emission	Sulfur dioxide	0.000000709			kg	Air	
	Output	Product	Biogas from sewage sludge	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Biogas from sewage sludge, cradle-to-gate, system expansion, impact categories only - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Biogas from sewage sludge, cradle-to-gate, system expansion, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of biogas from sewage sludge
Process Type	Cradle to gate
Site	
Sector	Fuel

Owner	
Technical system description	This dataset represents a model of the cradle to gate production of Biogas from sewage sludge valid for Sweden. The following process is covered: - upgrading (water scrubber technique) and purification of raw gas at the sewage treatment plant. Anaerobic digestion, digestate use and treatment and additional methane leakage are not included since these processes are inherent parts of the waste water treatment in Sweden. All electricity input in the production is Swedish grid mix. The study is based on the technology of the Käppala sewage treatment plant (Swedish state-of-the-art). Data in Palm and Ek et al. are only published as impact categories and not as emissions except for particles.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Southern Sweden.
Other Boundaries	
Allocations	No.
Systems Expansions	Digestate is replacing mineral fertilizer.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	Approximate electricity generation with biofuel in modern power plant in Europe.
Method	Literature studies
Literature Reference	Palm, D. and Ek, M., 2010, Livscykelanalys av biogas från avloppsreningsverksslam, Report nr 219 SGC.
Notes	

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Not mentioned	Input	Resource	Primary energy	0			MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. Table 4.2.	Output	Emission	Acidification (AP)	-0.000093			kg	Air	
Notes: Given as kg PO4-eq combined emissions. Table 4.2.	Output	Emission	Eutrophication (EP)	-0.0000069			kg	Air	
Notes: Given as kg CO2-eq combined emissions. Table 4.2.	Output	Emission	Global warming (GWP)	-0.0055			kg	Air	
Notes: Table 4.2.	Output	Emission	Particles (unspecified)	-0.000019			kg	Air	
Notes: Given as kg ethene-eq combined emissions. Table 4.2.	Output	Emission	Photo-oxidant formation (POCP)	-0.0000026			kg	Air	
Notes: Table 4.2.	Output	Product	Biogas from sewage sludge	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	

Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Biogas from sugar beets, cradle-to-gate, no allocation - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Biogas from sugar beets, cradle-to-gate, no allocation - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of biogas from sugar beets
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of biogas from sugar beets valid for southern Sweden. The following process are covered: - Cultivation of the sugar beets - Harvest - Distribution to the fuel plant - Production of biogas The mineral fertilizer used is assumed partly to be produced in Western Europe (about 60 %) with present level of cleaning equiptment etc., and partly imported from countries outside Europe (about 40 %). This implies that about 30 % of the mineral fertilizer production takes place in plants with nitrous oxide cleaning where the nitrous oxide emission levels are reduced with about 80 %. All electricity input in the ethanol-plant is Swedish grid mix. Fuel used at the biogas plant for heating is biogas from the plant itself. Allocation is made based on energy content (only case showed in Miljöfaktaboken, since this allocation method is preferred by the Renewable Energy Directive), however a case with system expansion is made in Börjesson et al. which also has been published in the f3 database. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included. Impacts from production of buildings and infrastructure are not included.

System Boundaries	
Nature Boundary	

Time Boundary	2010 - 2013
Geographical Boundary	Cultivation of sugar beets (assumed on good soil) and handeling and storing of waste and manure is in southern Sweden.
Other Boundaries	
Allocations	The outputs from the anaerobic digestion are biogas and digestate. Emissions and primary energy demand are all allocated to the biogas. 100 % of the process outputs are thus allocated to the biogas.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	Approximate electricity generation with biofuel in modern power plant in Europe.
Method	Literature studies
Literature Reference	Gode, J. et al., 2011, Miljöfaktaboken 2011, Uppskattade emissionsfaktorer för bränslen, el, värme och transporter, Värmeforsk Data in Gode et al. Are based on: Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH. Bu
Notes	

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Only energy use, not the energy embedded in the product. Börjesson is not stating what different energy carriers that are included in the primary energy. There is no primary energy factor given.	Input	Resource	Primary energy	0.4			MJ	Ground	
	Output	Emission	Carbon dioxide (fossil)	0.0132			kg	Air	
	Output	Emission	Carbon monoxide	0.0000168			kg	Air	
Notes: Methane emissions can vary extensively between sites.	Output	Emission	Methane (biogenic)	0.000103			kg	Air	
	Output	Emission	Nitrate	-0.000462			kg	Water	
	Output	Emission	Nitrogen oxides	0.000127			kg	Air	
	Output	Emission	Nitrous oxide	0.0000077			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	0.0000000034			kg	Air	
	Output	Emission	Particles (unspecified)	0.0000036			kg	Air	
	Output	Emission	Sulfur dioxide	0.0000104			kg	Air	
	Output	Product	Biogas from sugar beets	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	

About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Biogas from sugar beets, cradle-to-gate, system expansion, impact categories only - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Biogas from sugar beets, cradle-to-gate, system expansion, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of biogas from sugar beets
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of biogas from sugar beets valid for southern Sweden. The following processes are covered: - Cultivation of the sugar beets - Harvest - Distribution to the fuel plant - Production of biogas The mineral fertilizer used is assumed partly to be produced in Western Europe (about 60 %) with present level of cleaning equiptment etc., and partly imported from countries outside Europe (about 40 %). This implies that about 30 % of the mineral fertilizer production takes place in plants with nitrous oxide cleaning where the nitrous oxide emission levels are reduced with about 80 %. All electricity input in the ethanol-plant is Swedish grid mix. Fuel used at the biogas plant for heating is biogas from the plant itself. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included. Impacts from production of buildings and infrastructure are not included. Data in Börjesson et al. are only published as impact categories and not as emissions except for particles.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Cultivation of sugar beets (assumed on good soil) and handeling and storing of waste and manure is in southern Sweden.
Other Boundaries	
Allocations	No.

Systems Expansions	A byproduct from the production is digestate. 1 kg nitrogen in the original raw material is replacing 0.7 kg mineral fertilizer nitrogen (equivalent of nitrogen accessible to plants including losses in the handling of digestate) and 1 kg phosphorus and potassium, respectively, in the digestate is replacing 1 kg phosphorus and potassium, respectively, in mineral fertilizer. Utilization of tops and leaves is included. Reference: table 2.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	Approximate electricity generation with biofuel in modern power plant in Europe.
Method	Raw material: General – Processed official statistics Transformation: Mainly general – Preliminary studies Reference: table 1
Literature Reference	Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH.
Notes	

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Not mentioned in Börjesson	Input	Resource	Primary energy				MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. Table 10	Output	Emission	Acidification (AP)	0.000156			kg	Air	
Notes: Given as kg PO4-eq combined emissions. Table 9	Output	Emission	Eutrophication (EP)	0.000074			kg	Air	
Notes: Given as kg CO2-eq combined emissions. Table 7	Output	Emission	Global warming (GWP)	0.0125			kg	Air	
Notes: Table 12	Output	Emission	Particles (unspecified)	0.0000013			kg	Air	
Notes: Given as kg ethene-eq combined emissions. Table 11	Output	Emission	Photo-oxidant formation (POCP)	0.0000025			kg	Air	
	Output	Product	Biogas from sugar beets	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Biogasification of solid municipal waste

Administrative

Finished	Y
Date Completed	2002-08-14
Copyright	McDougall F. et al, Integrated Solid Waste Management
Availability	Public

Technical System	
Name	Biogasification of solid municipal waste
Functional Unit	1 tonne of biowaste
Functional Unit Explanation	1 tonne of biowaste contains non-recyclable paper (15%) and wet organic waste (85%). Figures based on O.E.C.D, Environmental Data Compendium, Organisation for Economic Cooperation and Development. Paris, 1997.
Process Type	Gate to gate
Site	Europe
Sector	Waste treatment
Owner	Europe
Technical system description	Biogasification is an anaerobic metabolism, i.e. it occurs in the absence of oxygen. Through this anaerobic process biowaste (non-recyclable paper and organic waste) is transformed to compost, biogas and refining residue. It involves both consumption of energy during processing and production of useful energy as biogas. In this LCI model it is assumed that the biogas is burned on-site for power generation, and that surplus energy is exported as electrical energy. Anaerobic treatment of organic material is basically a two-stage process; large organic polymers are fermented into short-chain volatile fatty acids. These acids are then converted into methane and carbon dioxide. Condition for biogasification need to be anaerobic, therefore a totally enclosed process vessel is required. There are wet and dry processes for biogasification, this acitity is representing a wet process. - Air emissions from the anaerbic treatment; the composition of biogas is about 45% CO2, 54% CH4. When burned, methane also forms carbon dioxide, which is a contributor to the greenhouse effect. Overall carbon dioxide emissions from a biogasification plant is assumed to be 440 kg per tonne of wet organic material. (McDougall, 2001) Biogas also consist of chlorine H2S, HC and chlorinated HC (N2 and O2 is also possible) but these are not emitted to the air. The amount of biogas produced will depend on the nature of the organic material in the incoming waste, as well as the process used. - Water emissions from the anaerbic treatment; water is produced when the digested material is pressed or filtered. Large amount will be produced, especially in the wet process type. Some of it will be recirculated and the rest need to be treated prior to discharge. Water emissions are based on a wet two stage process producing 500 l/tonne. In this model only output of electricity is presented since production and incineration of biogas result in electricity used in the plant. Energy consumption is 50 kWh/tonne of plant input and energy production is 190 kWh/tonne of process input.(McDougall, 2001) The composition of biogas can be: CO2 45%, CH4 54%, Chlorine 0.9 mg/m3, H2S 420 mg/m3, Total HC <1.5, Chlorinated HC <1.5 (N2 and O2 is also possible). (McDougall, 2001) Mass loss due to evaporation and biodegradation of the organic fraction of final vary between 40- 80% (McDougall, 2001) Due to the wide range of different biogasification processes available mass loss vary. 60 % is a generic value used here. References: Integrated Solid Waste, F.McDougall et al, Blackscience, 2001 Bergmann and Lentz, Report, Procter and Gamble, Germany, 1992.

System Boundaries	
Nature Boundary	A biogasification plant require a considerable area of land but due to lack of data this is not included in the system. The energy consumption and the emissions to air and water are accounted for. The emissions to air and water have nature as recipient. Reported emissions are the ones measured in the study. The fact that emissions on different geographical places can have different effects on the environment has not been accounted for.
Time Boundary	Data are from studies made 1992- 2001.

Geographical Boundary	The technical system for this model is limited to a biogasification plant in Europe.
Other Boundaries	Subsystem not considered is transports from sorting station to biogasification area.
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	Derived, unspecified
Represents	Approximate electricity generation with biofuel in modern power plant in Europe.
Method	All LCI data are taken from the literature references, see specific for details.
Literature Reference	Integrated Solid Waste- A Life Cycle Inventory, F.McDougall et al, Procter and Gamble Technical Centres Limited, Germany, Blackwell science, 2001. Bergmann and Lentz, Vorstudie zu einer Ökobilanz uber biologische Abfallbehandlungsverfahren, Report, Procter & Gamble GmbH, Schwalbach, Germany, 1992.
Notes	

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: The composition of the waste is 15 weight-% of recyclable paper and 85 weight-% of wet organic material. Literature: McDougall, 2001	Input	Refined resource	Biowaste	1			tonne	Technosphere	
Method: Production of electricity (from biogas) is 190 kWh/tonne of process input and electricity consumption is 50 kWh/ tonne of process input. The total energy production is thus 140 kWh/tonne of waste input. (Schön, 1992) (McDougall, 2001) The composition of biogas can be: CO2 45%, CH4 54%, Chlorine 0.9 mg/m3, H2S 420 mg/m3, Total HC <1.5 mg/m3, Chlorinated HC <1.5 mg/m3 (N2 and O2 is also possible). (McDougall, 2001) Methane has a calorific value of 37.75 MJ/Nm3 (Perry and Green, 1997) which makes it suitable for production of electricity. Literature: Schön. M, Anaerobtechnik- , University of Kassel, 1992 Perry and Green, The chemical engineer's handbook, 7th edition, McGraw Hill, London, 1997 Notes:	Output	By-product	Electricity	140			kWh	Technosphere	
	Output	Emission	Alcohols	0.033			g	Air	
	Output	Emission	Aldehydes	0.086			g	Air	
Method: Water emissions are based on a wet two stage process producing 500l/tonne of biowaste. Emission data are taken Bergmann and Lentz (1992). Literature: Bergmann and Lentz, report, Procter and Gamble, Germany, 1992	Output	Emission	BOD	30			g	Water	
Method: 440 kg CO2 is emitted from a biogasification plant per tonne of incoming wet organic material. Included are CO2 from biogas which contains of 45 % CO2 and CO2 formed when methane in biogas is burned . 440kg * 0.85 (85% wet organic material) * 0.975 (since 2.5 % become Slags and ash) = 364.65 kg	Output	Emission	CO2	364.65			kg	Air	
Method: Water emissions are based on a wet two stage process producing 500 l/tonne of biowaste. Emission data are taken from Bergmann and Lentz (1992). Literature: Bergmann and Lentz, report, Procter and Gamble, Germany, 1992	Output	Emission	COD	100			g	Water	
	Output	Emission	Esters	0.003			g	Air	
	Output	Emission	Ethers	0.027			g	Air	
	Output	Emission	ketones	0.466			g	Air	

Method: Water emissions are based on a wet two stage process producing 500l/tonne of biowaste. Emission data are taken from Bergmann and Lentz (1992). Literature: Bergmann and Lentz, report, Procter and Gamble, Germany, 1992	Output	Emission	N total	0			kg	Water	
	Output	Emission	NH3	97.6			g	Air	
Method: Water emissions are based on a wet two stage process producing 500 l/tonne of biowaste. Emission data are taken from Bergmann and Lentz (1992). Literature: Bergmann and Lentz, Report, Procter and Gamble, Germany, 1992	Output	Emission	NH4+	50			g	Water	
	Output	Emission	Organic sulphides	0.202			g	Air	
	Output	Emission	Terpenes	2.2			g	Air	
Method: 2.5 % of the organic material and 2.5% of the treated paper fractions are added to the residue. 60% mass losts during treatment gives 11 115 tonnes of produced compost.	Output	Product	Compost	390			kg	Technosphere	
Method: 2.5 % of the treated organic material and 2.5% of the treated paper fractions are added to the residue. Literature: Bergmann and Lentz, Report, Procter & Gamble, Germany, 1992	Output	Residue	Slags and ash	25			kg	Technosphere	

About Inventory	
Publication	McDougall F. et al, Integrated Solid Waste Management - A Life Cycle Inventory, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Data documented by: Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, Industrial Environmental Informatics, Chalmers University of Technology Published in SPINE@CPM: 14 August 2002
Intended User	The original study this docume
General Purpose	Data about waste management systems are insufficient and more data are required by the industry.
Detailed Purpose	This documentation is based on a study about Integrated Solid Waste Management performed by Forbes McDougall et al at Procter & Gamble Technical Centres, 2001. The aims of that study was to introduce a LCI model for Integrated Waste Mangement and to provide data that support the concept of Integrated Waste Management as a sustainable method of managing solid waste. The purpose of the documentation of this system has been to make data for waste management available in this format for the industry.
Commissioner	
Practitioner	
Reviewer	
Applicability	This set of data could be applied to a biogasification plant and it gives a rough estimation of environmental loads of the anaerobic process. For detailed study of biogasification more information is needed e.g. about the composition of the input waste, biogasification process etc. The various biogasification processes can be classified according to the solids content of the material digested, and the temperature at which the process operates. Dry anaerobic digestion may be defined as taking place at a total dry solids concentration of over 25%, below this concentration the process is described as wet digestion. To give an indication of how much biowaste usually is generated in urban areas the following example is given. A population of 500 000 with a total amount of waste generated of 230 000 tonnes, gives around 28 500 tonnes of biowaste, 4275 tonnes (15 weight-%) of non-recyclable paper and 24 225 tonnes (85 weight-%) of organic material. These figures vary between countries and areas.
About Data	Data is based on a study performed by Procter & Gambler about Integrated Waste Management (F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001). Data are generally averages, giving an approximate measure of the environmental burdens

	associated with the system. The descriptions of the activity is how it was understood by the person who made the documentation. Water emissions are based on a wet two stage process producing 500 l/tonne waste treated.
Notes	For further information about solid waste managment see: Flemström K., Brief overview of solid waste management, IMI-internal report. The report may be downloaded from: http://www.imi.chalmers.se

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SPINE LCI dataset: Bore-hole based air-conditioning system. ESA-DBP

Administrative	
Finished	Y
Date Completed	2007
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Bore-hole based air-conditioning system. ESA-DBP
Functional Unit	Air-conditioning system which conditions and distributes a variable airflow volume (VAV) of a max. 5 m3/s
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The air-conditioning system includes the cooling and the air distribution systems. The required temperature of the supply is 15 °C all during the year, and the room temperature varies from 20 °C to 25.5 °C. The system operates for 11h (7am-18pm) each working day, 5 days a week. The lifesplan of this system as an entity is estimated to be 15 years.'' The data are valid for 1 year.
Process Type	Cradle to grave
Site	Akademiska Hus AB, Göteborg, Sweden
Sector	Goods and services for households
Owner	Akademiska Hus AB, Göteborg, Sweden
Technical system description	Schematics of the system can be found in the reference report (see 'Publication'). Excerpt from the report, see 'Publication': ''The air-conditioning system studied was installed to provide a building complex with ventilating air which should also lead off the surplus heat from the premises. Heating of the premises, provided by a separate water loop heating system, is not included in the scope of this study. (...) The gross area of the premises is 5000 m2, or 2500 m2 for each of the buildings. In each of the buildings, a new all-air, air-conditioning systems has been installed. The source of heating and cooling energy for the building complex is a bore-hole based heat pump system. (...) The system (...) consists of an air-handling unit, an air distribution system (air ducts and supply air terminal devices), and the bore-hole system which is the energy source for heating and cooling of the supply air. The heating coil in the exhaust part of the air-handling unit is used to heat supply air when required and to lead off the heat surplus from the heat pump system when it is operating it the cooling mode. Calculations of materials and energy use for the two air-conditioning systems are based on the design documents for system A (NB: bore-hole system), since both system alternatives are designed for the same building. (...) Although the disposition of the storeys differs slightly, for the estimation of the energy use, they are assumed to be similar. The total net area of the buildings is 1920 m2, which is mostly divided into cell offices and an auditorium for 150 persons. The total internal loads are assumed to be 40 W/m2, accounting for 10 W/m2 for people, and 15 W/m2 each for lighting and computerised equipment. (...) The production stage includes the assembly of the air distribution system in the building. User stage of the life cycle includes electricity for operation of the air-handling unit and the cooling system, required heat energy, and the leakage of the refrigerant. (...)

	Electricity amounts for operation of the air-handling units are estimated by using a specific fan power (SFP) factor of 1.1 kW/(m3/s) when distributing 80% of the maximum airflow, which corresponds with an SFP of 2.1 for the maximum airflow. Air is distributed in the building via a novel construction of a VAV supply air volumes at low air temperatures, 15° and lower, without a draught problem. (...) 67% of the required cooling energy is supplied by 'free' cooling energy from the bore holes; the rest is provided by the heat pump system. The bore-hole system is assumed to work in the refrigeration mode in accordance with a seasonal performance factor (SPF) of 2.5. (...) The environmental impacts of the disposal stage are calculated for material recycling (metals 95%, polyethylene 90%), for inineration with energy recovery (100% of the other plastics, 10% of polyethylene), and for land-filling (5% of all metals, 100% of the mineral wool insulation). Main assumptions made for this study are (NB: based on the comparative table): all-air; bore-hole based heat pump; variable airflow; air-conditioning system; life cycle phases: production, user, disposal; office area: 1920 m2; total airflow: 5 m3/s; supply air temperature: 15°C, exhaust air temperature 22.5 °C; internal heat loads 40 W/m3; cooling loads: 124 MWh/year; operating time: 8760 h/year, SFP: 1.1 kW/(m3/s), life span: 15 years. This process is included in the system described in: Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007 Other processes in the CPM Database also included in the above publication: - Air-conditioning system. ESA-DBP - Air-and-water air conditioning system. ESA-DBP - All-air air handling unit with a cooling coil and vapour compression chiller with a refrigerant. ESA-DBP - All-air desiccant cooling air handling unit. ESA-DBP - Operation on desiccant cooling system - a technology in air conditioning. ESA-DBP - Operation on vapour compression cooling system - a technology in air conditioning. ESA-DBP

System Boundaries

Nature Boundary	In the study production, user and disposal stages are considered. The inventory analysis included parameters describing resource use and emissions to air and water.
Time Boundary	Excerpt from the report, see 'Publication': ''The technical performance of this system was monitored from May 2004 to September 2005.''
Geographical Boundary	Göteborg, Sweden
Other Boundaries	Excerpt from the report, see 'Publication': ''The environmental impact (...) is analysed by taking into account the production of materials that comprise them, the energy use for the operation of the systems, and their eventual removal. The air distribution system in the building is also included in the analysis. During the lifespan of each system, supply and exhaust air filters have to be replaced according to a predefined time schedule. As shown in earlier studies, the impact of the filter materials and their amounts (mostly sheet steel and rock wool) on the environmental performance of the whole system is negligible. Therefore, these material amounts are excluded from this analysis. Moreover, components such as silencers, dampers, various valves and screws are also excluded. Neither the transports of materials to the producers, nor to the building site, are taken into account according to the assumption that the transportation distance is equivalent for both systems and would thus not affect results.''
Allocations	Excerpt from the report, see 'Publication': ''The bore-hole system supplies two air-conditioning systems with cooling and heating energy, as well as contributing to heating of the building complex. The allocation of the environment impacts related to the bore-hole system, therefore, is made according to the following procedure. - The allocation of the component materials of the bore holes, between the heating (during the winter) and the cooling (during the summer) systems, is made according to the ratio of the design capacity required for cooling to the total (heating and cooling) design capacity. - The allocation of the component materials of the heat pump system between the two air-conditioning systems (one for Academicum and one for the renovated building) is performed according to the ratio of the maximum cooling capacities required of the first to the sum of two. - The allocation of cooling energy demand is made in accordance with the specification of the property owner that the bore-hole system supplies 2/3 of the cooling energy demand from the bore-hole storage; 1/3 is supplied by the heat pump system working in a cooling mode. - During the coldest period of the year, the heat energy demand for conditioning of the supply air is very low due to the combination of an efficient heat energy recovery and a low supply air temperature. Heat energy is supplied by the heat pump and the bore-hole system.

Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''The amounts of component materials for the air-handling unit are deteremined by approximations based on a previously published LCA study. Data for the bore-hole pipes are supplied by their producer, and data for the heat pumps are based on the data used in an earlier study published by the author. (...) The life cycle inventory data for the component materials and energy sources are obtained from the software application EPS Design Systens 4.0''
Literature Reference	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/Heikkila_et_al_2007
Notes	

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Resource	Aluminium ore	1.80E+02			kg	Ground	Sweden
	Input	Resource	Chromium ore	1.34E+01			kg	Ground	Sweden
	Input	Resource	Coal in ground	5.19E+04			kg	Ground	Sweden
	Input	Resource	Copper ore	1.04E+01			kg	Ground	Sweden
	Input	Resource	Forestland occupation	4.10E+01			kg	Ground	Sweden
	Input	Resource	Iron ore	1.32E+03			kg	Ground	Sweden
	Input	Resource	Molybdenum ore	6.00E-01			kg	Ground	Sweden
	Input	Resource	Nickel ore	6.00E+00			kg	Ground	Sweden
	Input	Resource	Oil in the ground	7.31E+03			kg	Ground	Sweden
	Input	Resource	Zinc ore	3.54E+01			kg	Ground	Sweden
	Output	Emission	BOD	4.10E-02			kg	Water	Sweden
	Output	Emission	CH4	1.60E+00			kg	Air	Sweden
	Output	Emission	CO	4.00E-02			kg	Air	Sweden
	Output	Emission	CO2	2.06E+05			kg	Air	Sweden
	Output	Emission	COD	3.00E-01			kg	Water	Sweden
	Output	Emission	Dust	2.60E+00			kg	Other	Sweden
	Output	Emission	Formaldehyde	2.00E-01			kg	Air	Sweden
	Output	Emission	HCl	8.00E-01			kg	Air	Sweden
	Output	Emission	HFC-125	2.70E+00			kg	Air	Sweden
	Output	Emission	HFC-134a	4.20E+00			kg	Air	Sweden
	Output	Emission	HFC-32	2.60E+00			kg	Air	Sweden
	Output	Emission	Litter	7.00E-01			kg	Other	Sweden
	Output	Emission	N2O	2.00E-02			kg	Air	Sweden
	Output	Emission	NMVOC	9.20E+00			kg	Air	Sweden
	Output	Emission	NOx	3.60E+02			kg	Air	Sweden
	Output	Emission	N-tot	1.00E-02			kg	Water	Sweden
	Output	Emission	SOx	8.52E+02			kg	Air	Sweden

About Inventory

Publication	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''An objective of this work was that it should lead to an increased knowledge of how to work with environmental issues related to air-conditioning systems for office buildings and to a greater awareness of the environmental loads related to these systems. (...) The objectives of this thesis are to: - describe how the environmental performance of air-conditioning systems can be assessed and evaluated at the design stage. The focus is on the application of existing methods for

	environmental assessment of these systems. - identify and discuss the major sources of the environmental impacts and give some general recommendations as to how to design air-conditioning systems to improve their environmental performance. - outline possible key performance indicators (KPI) for the environmental performance of the most common types of air-conditioning systems.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The purpose of this study is to evaluate the environmental impact of the bore-hole system (...) taking into account its entire life cycle. Results of this study are intended to provide both designers and decision makers with relevant information about the environmental performance of this system, and thus to enable them to identify possible modifications of the system design to improve the environmental performance of similar systems.''
Commissioner	Unknown - .
Practitioner	Katarina Heikkilä - .
Reviewer	Jan-Olof Dalenbäck, Torbjörn Lindholm, - Building Services Engineering, Energy and Environment, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	For more information and the comparison with the other systems see the report. The reference report is a thesis for the degree of doctor. As a part of it, seven papers are included. Paper V ''Environmental evaluation of an air-conditioning systems supplied by cooling energy from a bore-hole based heat pump system'' relates to the analysis of air-conditioning system. The function and other information was taken from the mentioned Paper V. Inventory data come from the main part of the report.

SPINE LCI dataset: Cable assembly

Administrative	
Finished	Y
Date Completed	2000-03-08
Copyright	Ericsson
Availability	Official

Technical System	
Name	Cable assembly
Functional Unit	One gram cable
Functional Unit Explanation	The motivation for choosing this functional unit is: · Suitable unit to work with in an LCA of a private branch exchanges (a complicated telecom product) · Important component of the MD110 product system and many other electronic products. The answers from component manufacturer one (CM1) and component manufacturer two (CM2) are not for the same cable. These facts are based on Ericsson technical specification of the component. DESIGN -- Component manufacturer one -- Ericsson product number: TFK 100 506/08 Ericsson description: Installation cable Conductor (Several threaded conductor of smooth heated copperwire, free from oxide

	patterns. Insulation: One layer coloured and plastizied polyvinylchloride which can be co-polymerized with vinyl acetate, thickness 0,1 mm Sheath: Conductorarea: 10 mm2 Max threaddiameter: 0,41 mm Isolation thickness: 1 mm Outer diameter: 7,6 mm -- Component manufacturer two -- Ericsson product number: TEN 250 3402/008 Ericsson description: Switchboard cable Conductor (solid, annealed, tinned copper wire, diameter 0,4 mm) Insulation: Polyamdie, PA 12, thickness 0,1 mm Sheath: Plastized PVC WITH GREY COLOUR, thickness 0,7 mm flame retardant oxygen index = 28 or greater according to ASTM D 2863 No. of pairs: 8 Overall diameter: 5,0 mm Weight: 35 kg/km
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of cables. The activity is an average based on information acquired from two manufacturers. The description of the process is supplied by both manufacturers. The following process steps are included for manufacturer one; 1. Arrival of goods 2. PVC processing 3. Copper from conductor from reel, PVC compound from silo and Color masterbatch is put into the extruder 4. Extruder process 5. Measuring 6. Cooling 7. Electrical testing 8. Testing on reel Manufacturer one (CM1) has given some more details about the assembly. See additional information below. Manufacturer two (CM2) gave information about which process steps they had: 1. Wire drawing 2. Inspection of wire 3. Electrolytic tinning 4. Inspection of wire 5. Fine wire drawing 6. Insulation 7. Stranding 8. Sheathing 9. Inspection by quality control 10. Marking and packing but no details. Additional information: Below are some additional information supplied by each of the included component manufacturers. --Component manufacturer one -- The annual production is 60,000 meters. 1. Arrival of goods Raw material e.g. aluminium, copper, polyethylene, PVC, fillers, softeners, stabilisers etc is delivered by truck and train. 2. PVC processing PVC is processed in a compounding plant. 3. Copper from conductor from reel, PVC compound from silo and Color masterbatch are put into the extruder Aluminium and copper rods are drawn down to thinner wires and used as solid conductors or twisted together to stranded cores.

Polyethylene is delivered in bulk cargo to silo or in cartoons.

4. Extruder process

The conductors are pulled through the tools in a plastic extruder line and the plastic is formed around the conductor with tolerances according to cable construction.

This can be repeated in several steps depending on the cable construction.

All relevant testing is made on the material and on the cable during the different steps of the production in order to fulfil authority and customer as well as internal demands.

The finished cable is taken up on reels or packed in other packages according to customer needs.

The stranded copper conductor is pulled of from the wind off through the extruder where the PVC has been melted and mixed with the colour master batch.

5. Measuring

The measuring and control equipment measures the diameter of the cable and controls the line in order to keep the tolerances according to cable construction.

6. Cooling

The cable is cooled down to approximately 30º C.

7. Electrical testing

The cable runs through a electric testing equipment

8. Testing on reel

and is after that marked with an ink jet printer and taken up on a drum.

Packaging material for incoming materials is not included.
Cable package, (i.e. wooden drum), is not included.
Energy for heating of factory is not included.

Recycling can be made in two different operations.

1/ The Plastic extruder is heated up in order to get the correct viscosity on the PVC. During this start up procedure, the melted PVC is granulated in a hot melt granulater. The granules are later used as raw material in filler mixtures.

2/ During start up of an extruder line it takes some time to reach the correct dimension and quality of the cable. This scrap, which is PVC insulated copper conductor, is sent to a sub supplier, who granulate the cable scrap and separate copper from PVC.
The recycled copper is used to produce new copper.
PVC is placed in separate disposal for future use.

-- Component manufacturer two --

The annual production is 5,000,000 meters.

System Boundaries

Nature Boundary	The emissions to air have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impact has been studied. Included component manufacturers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used. Emissions to water and soil are excluded due to lack of data.
Time Boundary	1998 The answer from the manufacturer arrived in 1998 and they measured in 1998. The process technology used is most certainly the best available as the factories are located in Sweden and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturers included in the average are located in Sweden.
Other Boundaries	Delimitation's to the system is the final step in the making of the cable. The production of the subparts (e.g. Copper, PVC, CaCO3 and softener) of the cable is not included in this model The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability. Component manufacturer one has specifically stated that the following parameters have not

	been included: - Packaging material for incoming materials is not included. - Cable package,(i.e. wooden drum), is not included. - Energy for heating of factory is not included.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The data that are presented are calculated as an average based on information from two component manufacturers. The information from the manufacturers was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers In the information supplied by the manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+.+.ACn Step 2: The sum AC11+.+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to two answers was made.
Literature Reference	Two answers on the Ericsson products TFK 100 506/08 and TEN 250 3402/008 as well as http://www.chemfinder.com/
Notes	CM1 = component manufacturer one CM2 = component manufacturer two INFORMATION ABOUT RECYCLING CM1: Recycling can be made in two different operations. 1/ The Plastic extruder is heated up in order to get the correct viscosity on the PVC. During this start up procedure, the melted PVC is granulated in a hot melt granulater. The granules are later used as raw material in filler mixtures. 2/ During start up of an extruder line it takes some time to reach the correct dimension and quality of the cable. This scrap, which is PVC insulated copper conductor, is sent to a sub supplier, who granulate the cable scrap and separate copper from PVC. The recycled copper is used to produce new copper. PVC is placed in separate disposal for future use.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 5,6 g/110,91 g = 0,0505 g/g Searching DIDP at http://www.chemfinder.com/ gives the name 2'-deoxyinosine-5'-diphosphate This is not an average value and the figure is based only on one answer.	Input	Refined resource	2-deoxyinosine-5-diphosphate (DIDP)	0.051			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 3,4 g/110,91 g = 0,0306 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Ca(OH)2	0.031			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 90,7 g/110,91 g = 0,817 g/g CM2: 19950 mg/34490,5 mg = 0,578 g/g (CM1+CM2)/2 = 0,697 g Cu/g cable Notes: CM1 = component manufacturer one CM2 = component manufacturer two	Input	Refined resource	Copper	0.7			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,22 g/110,91 g = 0,00198 g/g CM2: 11,3 mg/34490,5	Input	Refined resource	Dyes	0.0012			g	Technosphere	

mg = 0,000327 g/g (CM1+CM2)/2 = 0,00115 g Dyes/g cable									
Date concieved: 1998 Data type: Derived, unspecified Method: The component manufacturer states an energy use of 330 kJ/m cable = 91,667 Wh/m. One metre of cable weighs 110,91 grams. I.e. 91,667/110,91 Wh/g = 0,826 Wh/g. This is not an average value and the figure is based only on one answer.	Input	Refined resource	Electricity	0.83			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 2946 mg/34490,5 mg = 0,0854 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polyamides	0.085			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 531,1 mg/34490,5 mg = 0,0154 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polyester	0.015			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 22,1 g/110,91 g = 0,199 g/g CM2: 15277 mg/34490,5 mg = 0,443 g/g (CM1+CM2)/2 = 0,32 g Cu/g cable	Input	Refined resource	Polyvinyl Chloride	0.32			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 262,7 mg/34490,5 mg = 0,00761 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Sn	0.0076			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The component manufacturer states an emission of 1,6 mg for a cable which weighs 110,91 grams. Hence, 1,6e-3/110,91 =1,44e-5 g Softener, DIDP Searching DIDP at http://www.chemfinder.com/ gives the name 2'-deoxyinosine-5'-diphosphate This is not an average value and the figure is based only on one answer.	Output	Emission	2-deoxyinosine-5-diphosphate (DIDP)	0.000014			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: 1 gram cable output is the base for all figures in this model. Cables = Life Cycle Inventory model for production of one gram of cable (applicable to telecommunication equipment) (This model is based on two answers for one PVC-insulated flexible cable and one polyamide insulated pair cable with PVC sheath and conductor diameter 0,4 mm).	Output	Product	Cables	1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1,7 g/110,91 g = 0,015 g/g Notes: All copper is recycled.	Output	Residue	Copper	0.015			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,41 g/110,91 g = 0,0037 g/g Notes: All PVC is recycled.	Output	Residue	Polyvinyl Chloride	0.0037			g	Technosphere	

About Inventory

Publication	Not available. -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --

Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a cable manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of cables and components in our telecom products. The usage for this set of data is life cycle assessments where cables are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly

	15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data could be applied to cables used in electronic equipment if you know how much the cables weigh. -- Transports. -- CM1 = Component manufacturer one The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport. -- Truck transportation: -- Component manufacturer one (CM1): Weight of component: 110.91 g PVC with weight 11.2 g is transported 450 km by road i.e. 11.2 g*450 km and Softener, DIDP 5.6 g*450 km. The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 7560 gkm/110.91 g = 68.16 gkm/g Component manufacturer two (CM2): Weight of component: 34.4905 g Polyamide with weight 2.946 g is transported 1250 km by road i.e. 2.946 g*1250 km, PVC 15.277 g*230 km, Polyester yarn 0.5311 g*580 and Ink 0.0113 g*640 km. 7511.48 gkm/34.4905 g = 217.78 gkm/g (CM1+CM2)/2 = 142.97 gkm/g -- Boat transportation: -- Component manufacturer one (CM1): Weight of component: 110.91 g Softener, DIDP with weight 5.6 g is transported 1000 km by boat i.e. 5.6 g*1000 km. The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 5600 gkm/110.91 g = 50.49 gkm/g Component manufacturer two (CM2): Weight of component: 34.4905 g Ink 0.0113 g*1200 km. 13.56 gkm/34.4905 g = 0.39 gkm/g (CM1+CM2)/2 = 25.44 gkm/g -- Train transportation: -- Component manufacturer one (CM1): Weight of component: 110.91 g Copper with weight 89 g is transported 650 km by train i.e. 89 g*450 km, PVC 11.2 g * 450 km, and CaCO3 3.4 g * 3.4 km.

	The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 65440 gkm/110.91 g = 590 gkm/g Component manufacturer two (CM2): Weight of component: 34.4905 g Copper rod wire with weight 19.95 g is transported 800 km by road i.e. 19.95 g*800 km and Tin 0.2627 g*800 km. 16170 gkm/34.4905 g = 468.83 gkm/g (CM1+CM2)/2 = 529.41 gkm/g
About Data	The data is based on information from two Swedish manufacturers. The information was gathered using a life cycle inventory questionnaire. All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model. Of the flows 75 % are not average values. The flows for Raw material input of Copper, Dyes and PVC are average values. In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included. The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. 15 % of the flows have been justestimated, 6 % have been calculated and 89 % of the flows have not been specified. The outline of the LCI data questionnaire that was used in the inventory follows below. No limitations or specifications were set for which substances they had to account -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes. Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gathered it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (E.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount (mg). Amount In Product (mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production sites (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil.

	Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Canada, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Canada, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Canada
Sector	Energyware
Owner	Canada
Technical system description	The generation of electricity with different power generating systems in Canada during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.

Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	18401			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	26085			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	3			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	32			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	331889			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	46697			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	60724			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	62			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	6290			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	71511			GWh	Technosphere	
Date concieved: 1998 Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	561694			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998

	Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Capacitor for hole mounting assembly

Administrative	
Finished	Y
Date Completed	2000-03-15
Copyright	Ericsson
Availability	Official

Technical System	
Name	Capacitor for hole mounting assembly
Functional Unit	One gram capacitor intended for hole mounting.
Functional Unit Explanation	The motivation for choosing this functional unit is: · Suitable unit to work with in an LCA of a private branch exchanges (a complicated telecom product) · Important component of the MD110 product system and many other electronic products. DESIGN The capacitor studied is a metallized plastic foil capacitor with polyester or polycarbonate dielectric material of equal size applicable to telecommunication equipment. The answers from component manufacturer one (CM1), component manufacturer two (CM2) and from the literature source are for the same component. Component manufacturer three (CM3) differs. See the specifications below. These facts are based on Ericsson technical specification of the component. --Component manufacturer one, two and literature source --

	Ericsson product number: RJA 392 26/47 Ericsson description: Capacitor Plastic foil or metallized plastic foil capacitor with polyester or polycarbonate dielectric material. Diameter: 7,5 mm Diameter terminals: 0,66 mm Height: 10 mm Width: 5 mm --Component manufacturer three -- Ericsson product number: RJE 315 2501 Ericsson description: Capacitor Polarized aluminium electrolytic capacitor. Diameter: 3.5-10.5 mm Diameter terminals: 0.3 mm Height: 4.9-10.8 mm Width: 4.1-10.5 mm
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of a capacitor intended for hole mounting. The activity is an average based on information acquired from three manufacturers and one literature source containing two useful datasets. The description of the process is supplied by manufacturer one, but is assumed to be general for this type of manufacture. The following process steps are included; 1. Film metallization 2. Slitting 3. Winding 4. Metal spray 5. Heat treatment 6. Sawing 7. Lead welding 8. Epoxy filling 9. Quality control 10. Taping 11. Laser marking Details given about the process steps: 1. Film metallization Alu-metallization under vacuum. 2. Slitting: Slitting of the motherreels to defined reels 3. Winding: To wind mother capacitors 4. Metal spray: Metal spray is used Tto contact the film by hot aluminium and tin lead 5. Heat treatment: In the heat treatment the stabilising of the mother caps is done. 6. Sawing: Sawing to cut the capacitors with nominal value from the mother cap. 7. Lead welding: Lead welding is done to weld copper wires at the contacts. 8. Epoxy filling: Encapsulation in a polyester box with filling of epoxy. 9. Quality control: Quality gate and sampling tests. 10. Taping: Taping according to customer requirement 11. Laser marking: Marking of each capacitor.

	Additional information: Below are some additional information supplied by each of the included component manufacturers. --Component manufacturer one -- The raw materials are delivered without exeption by German suppliers, so the longest transport distance is max. about 850 km. These transports are not included in this activity. The shooping wires (see Applicability) are needed for the metal-sprayed contact layer of the capacitor and the SnPb-shooping wire will later be broken down into the elements tin and lead. Electricity is generally used for the whole production process with the exception for the shooping process, where oxygen gas and acetylene are applicated. --Component manufacturer two- The annual production is 770,000,000 pieces. The Leads Coppereld consists of Steel 67.4 %, Cu 18.9 %, Sn 13 % and Pb 0,7 %. In 1999 the production is estimated to increase to 830.000.000 pcs/year.

System Boundaries

Nature Boundary	The emissions to air and water have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impact has been studied. Included component manufacturers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used.
Time Boundary	1998 The answer from the manufacturer arrived in 1998 and they measured in 1998. The process technology used is most certainly the best available as the factories are located in western Germany, Brasil, Japan and Sweden and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturers included in the average are located in western Germany, Brasil, Japan and Sweden.
Other Boundaries	Delimitation's to the system is the final step in the making of the HMD capacitor. The production of the subparts (e.g. Metal plastic film, accelerator, curing agent and plastic case) of the resistor is not included in this model The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability. Manufacturer two has specifically stated that these flows are not included in waste output for the model: Epoxy Resin 0,1 m3, Lubrificant Oil 0,96 m3, Solvents (Acetone) 0,12 m3, Metallized Waste (Tin) 1,4 m3, Mettalized Waste (Al) 1,17 m3 and Metal Spray with plastic 35 m3. All substances are controlled for governmental organisation and are measured in m3 All substances are deposed in waste deposit or recycled in other industries. The waste handling are not included.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The data that is presented is calculated as an average based on information from three component manufacturers and one literature source containing two useful datasets. The information from the manufacturers was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer and literature dataset - Then the calculated amount for each component manufacturer and the useful data literature dataset is summed for each unique flow and divided by the number of included component manufacturers and useful datasets from the literature. In the information supplied by the manufacturers, they had indicated whether the data for each flow were measured,

	estimated or calculated. In the literture Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+.+.ACn Step 2: The sum AC11+.+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to three answers and two useful datasets from the literature was made.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 1 mg/380,2 mg = 1,31e-3 g/g CM4: 5,5 mg/3732,59 mg = 1,47e-3 g/g CM5: 11 mg/3374,48 mg = 3,25e-3 g/g (CM2+CM4+CM5)/3 = 2,01e-3 g/g This is an average value based on three answers.	Input	Refined resource	Accelerator	0.00201			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Represents: This is probably an internal process chemical. CM2 has not stated Acetato NU-9 chemical composistion. Method: CM2: 4,1 mg/380,2 mg = 0,01078 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Acetato NU-9	0.0107			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0,6/380,2 = 1,58e-3 g/g CM4: 1004/3732,59 = 0,269 g/g (CM2+CM4)/2 = 0,135 g/g This is an average value based on two answers.	Input	Refined resource	Acetone	0.135			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 1,2/3732,59 = 0,00032 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Ag	0.00032			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Average value for diffent inventories of HMD capacitor production. CM1: 13/313,2 = 0,0415 g/g CM2: 42,8/380,2 = 0,1125 g/g CM3: 152/187 = 0,812 g/g CM4: 124 mg used/3732,59 mg g finished component = 0,033 g/g CM5: 43/3374,48 = 0,0127 g/g (CM1+...+CM5)/5= 0,2252 g Al/g	Input	Refined resource	Al	0.2252			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM3: 12/187 = 0,064 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Butyrolactone	0.064			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 2/313,2 = 6,38e-3 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Carbonic acid	0.00638			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 71/3732,59 =0,019 g/g This is not an average value and the figure is	Input	Refined resource	Cellulose acetate	0.019			g	Technosphere	

based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 91/313,2 = 0,29 g/g CM2: 13/380,2 = 0,034 g/g CM4: 94/3732,59 = 0,025 g/g CM5: 242/3374,48 = 0,072 g/g (CM1+CM2+CM4+CM5)/4 = 0,105 g/g This is an average value based on four answers.	Input	Refined resource	Copper	0.105			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 3,4/3732,59 =0,00091 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Cyclohexanone	0.00091			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 104/3732,59 =0,028 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Diacetone alcohol	0.028			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 20,8 kJ/3,6 per 380,2e-3 g--> 15,21053 Wh/g CM3: 2,73 Wh/187e-3 g = 14,59893 Wh/g CM4: 134 kJelectrical energy used for a capacitor which weighs 3,73259 g. 1 Wh = 3,6 kJ. (134/3,6) /3,73259 = 9,97 Wh/g (see Segerbergs report) CM5: 95 kJelectrical energy used for a capacitor which weighs 3,37448 g. 1 Wh = 3,6 kJ. (134/3,6) /3,37448 = 7,82 Wh/g (see Segerbergs report) Average value: (CM2+CM3+CM4+CM5)/4 = 11,882 Wh / g hole mounted resistor This is an average value based on four answers.	Input	Refined resource	Electricity	11.882			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 53/313,2 = 0,17 g/g CM2: 55,7/380,2 = 0,15 g/g CM4: 1638/3732,59 = 0,44 g/g CM5: 576/3374,48 = 0,17 g/g Average value (CM1+...+CM5)/4 = 0,2325 g/g This is an average value based on four answers.	Input	Refined resource	Epoxy	0.2325			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 16/313,2 =0,0511 g/g CM4: 1067/3732,59 = 0,286 g/g CM5: 236/3374,48 = 0,0699 g/g (CM1+CM4+CM5)/3 = 0,136 g/g This is an average value based on three answers.	Input	Refined resource	Hardener	0.136			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 74/3732,59 =0,02 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Lactic acid	0.02			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 72/3737,2 = 0,019 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Methanol	0.019			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 19/3737,2 = 0,0051 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Methyl chloride	0.0051			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 133/3737,2 = 0,00355 g/g This is not an average value and the figure is	Input	Refined resource	Methyl ethyl ketone	0.0355			g	Technosphere	

based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0,5/380,2 = 1,32e-3 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Oil, lubricant	0.00132			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 84/312,2 = 0,27 g/g CM2: 4,8/380,2 = 0,013 g/g CM4: 1084/3737,2 = 0,29 g/g CM5: 0,5/3374,48 = 0,00015 g/g (CM1+...+CM5)/4 = 0,14 g/g This is an average value based on four answers.	Input	Refined resource	Pb	0.14			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 179/3732,59 = 0,048 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	PC	0.048			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 57/313,2 = 0,18 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Poly(butylene terephthalate)	0.18			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 3 of the metallized plastic foil capacitor with polyester dielectric material (RJA 392) states their component weighs 187 mg and a use of 16 mg. That is, 16/187 g = 0,0856 g PPS used/g capacitor This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polyphenyl sulphide	0.02893			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM3: 1/187 = 0,0053 g/g CM4: 341/3732,59 = 0,091 g/g (CM3+CM4)/2 = 0,048 g/g This is an average value based on four answers.	Input	Refined resource	Polypropylene	0.048			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 56/313,2 = 0,18 g/g CM2: 89/380,2 = 0,23 g/g CM4: 1084/3737,2 = 0,29 g/g CM5: 271/3374,48 = 0,08 g/g (CM1+...+CM4)/4 = 0,195 g/g This is an average value based on four answers.	Input	Refined resource	Sn	0.195			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 46,6/ 380,2 = 0,122 g/g CM4: 269/3737,2 = 0,072 g/g (CM2+CM4)/2 = 0,097 g/g This is an average value based on two answers.	Input	Refined resource	Steel	0.097			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 11/380,2 = 0,0289 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Tetrachloroethylene	0.0289			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 27/3737,2 = 0,29 g/g CM5: 396/3374,48 = 0,08 g/g (CM4+CM5)/2 = 0,185 g/g This is an average value based on two answers.	Input	Refined resource	Zn	0.185			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 5/3737,59 = 0,00133 g/g This is not an average value and the figure is	Output	Emission	Acetone	0.00133			g	Air	

based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,6 mg/313,2 mg = 1,91e-3 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Al-metallized Polyethylene (terphtalate)	0.00191			g	Ground	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,2 mg/313,2 mg = 6,38e-4 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Carbonic acid	0.000638			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 3,4/3732,59 =0,00091 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Cyclohexanone	0.00091			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 0,5/3732,59 =0,000134 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Diacetone alcohol	0.000134			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 36/3732,59 = 0.0096 g/g CM5: 2,4/3374,48 = 0,00071 g/g (CM4+CM5)/2 = 0,0051 g/g This is an average value based on two answers.	Output	Emission	Hardener	0.0051			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 2/3732,59 =0,00053 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Lactic acid	0.00053			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 72/3732,59 =0,0192 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Lactic acid	0.0192			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 0.4/3737,2 = 0,000107 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Methanol	0.000107			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 19/3737,2 = 0,0051 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Methyl chloride	0.0051			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 0.7/3737,2 = 0,000187 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Methyl ethyl ketone	0.000187			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: 1 gram capacitor output is the base for all figures in this model. Capacitors, hole mounted = Life Cycle Inventory model for production of one gram of hole mounted capacitor (This model is based on three answers and one literature report for metallized plastic foil capacitors with polyester or polycarbonate dielectric material of equal size applicable to telecommunication equipment).	Output	Product	Capacitor for hole mounting	1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 2,54/3732,59 = 0,00068 g/g This is not an	Output	Residue	Accelerator	0.00068			g	Technosphere	

average value and the figure is based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 0,17/3732,59 = 4,55e-5 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Ag	0.0000455			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM3: 23/187 = 0,123 g/g CM4: 1,5/3732,59 = 0,0004 g/g CM5: 31/3374,48 = 0,0092 g/g (CM3+CM4+CM5)/3 = 0,0442 g/g This is an average value based on three answers.	Output	Residue	Al	0.0442			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1,8/313,2 = 5,74e-3 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Carbonic acid	0.00574			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 21/3732,59 =0,0056 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Cellulose acetate	0.0056			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 3,1/3732,59 = 0,00083 g/g CM5: 7,5/3374,48 = 0,0022 g/g (CM4+CM5)/2 = 0,0015 g/g This is an average value based on two answers.	Output	Residue	Copper	0.0015			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1,6 mg/313,2 mg = 5,1e-3 g/g CM4: 748/3732,59 = 0,2 g/g CM5: 23/3374,48 = 0,0068 g/g (CM1+CM4+CM5)/3 = 0,07 g/g This is an average value based on three answers.	Output	Residue	Epoxy	0.07			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,5 mg/313,2 mg = 1,596e-3 g/g CM4: 487/3732,59 = 0.13 g/g CM5: 8/3374,48 =0,0024 g/g (CM1+CM4+CM5)/3 = 0,045 g/g This is an average value based on three answers.	Output	Residue	Hardener	0.045			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0,5/380,2 = 1,32e-3 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Oil, lubricant	0.000891			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 7,1/3732,59 = 0,0019 g/g CM5: 0,02/3374,48 = 5,92e-6 g/g (CM4+CM5)/2 = 0,00095 g/g This is an average value based on two answers.	Output	Residue	Pb	0.00095			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 2,2/3732,59 = 0,00059 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	PC	0.00059			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 341/3732,59 = 0,0913 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Polypropylene	0.0913			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 8,5/3732,59 = 0,0023 g/g CM5: 35/3374,48 =	Output	Residue	Sn	0.0063			g	Technosphere	

0,01 g/g (CM4+CM5)/2 = 0,00633 g/g This is an average value based on two answers.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 8,6/3732,59 = 0,0023 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Steel	0.0023			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM4: 3,2/3732,59 = 0,00086 g/g CM5: 52/3374,48 = 0,0154 g/g (CM4+CM5)/2 = 0,0081 g/g This is an average value based on two answers.	Output	Residue	Zn	0.0081			g	Technosphere	

About Inventory	
Publication	Not available. -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a capacitor manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of HMD capcitors and resembling components in our telecom products. The usage for this set of data is life cycle assessments where capacitors intended for hole mounting are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of all component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly

	3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to capacitors intended for hole mounting in electronic equipment if you know how much the capacitors weigh. The model is also intended to be representative for small ceramic filters for hole mounting in electronic equipment. -- Transports. -- Here follows a more detailed description of transports of materials and components to the respective manufacturer factories. These transports are not included in the model. The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport. -- Truck transportation: -- ---Component manufacturer one (CM1)--- Weight of component: 0.3132 g CM1: ((850 km)* (Al-metallized PET-film dielectric 0.03 g + Al-shooping wire 0.013 + Tin 0.056 + Lead 0.084 + Copper 0.091 + Epoxy resin 0.053 + Hardener 0.016 + PBT-case 0.057 + H2CO3 rests 0.002))/313,2 = 1090 gm/g ---Component manufacturer two (CM2)--- Weight of component: 0.3802 g CM2: Metal spraying (Al plus SnCu) 0.186 g*1100 km/0.3802 = 538 gkm/g ---Component manufacturer two (CM3)--- Weight of component: 0.187 g CM3: (Al foil 19 mg * 700 km + IIR rubber 19*500 + Separator 4*400 + Al case 46*700 + Lead wire 6*500 + Base 16*500 + Electrolyte 12*1000) / 187 mg = 425,7 gkm/g ---Literature source (CM4)--- Weight of component: 3.73259 g CM4: (Solder 2,38 g * 300 km + Epoxy resin 1,64*950 + Dielectric A 1,48*2250 + Hardener 1,07*1725 + Acetone 1*500 + Lead wire 0,36*2200 +Polypropylene 0,34*1670)/3,73259 g

= 2493,6 gkm/g

---Literature source (CM5)---

Weight of component: 3.37448 g

CM5: (Dielectric B 1,42 g*900 km + PBT box 0,93*800 + Epoxy resin 0,57*950 + Zinc 0,33*1300 + Tin-Zinc 0,33*1300 + Lead wire 0,25 * 1250 + Hardener 0,24*1725)/3,37448 g = 1229,2 gkm/g

(CM1+...+CM5)/5 = 1130,9 gkm/g

-- Airplane transportation: --

---Component manufacturer two (CM2)---

Metallized plastic film 31,2 mg*11700 km/380,2 mg = 960 gkm/g

-- Boat transportation: --

---Component manufacturer two (CM2)---

{mg*km/mg)} (Copper 13*19000 + Tin 89*19000 + Lead 4,8*19000 + Plastic case 56,6*10400 + Epoxy resin 55,7*11700 + Steel 46,6*19000)/380,2 = 10930 gkm/g

---Component manufacturer two (CM3)---

Separator 4*50/187 = 1,07 gkm/g

---Literature source (CM4)---

CM4: (2,38 g * 500 km + 1,64*225 + 1,48*1025 + 1,07*225 + 1*200 + 0,36*120 + 0,34*225)/3,73259 g = 974 gkm/g

---Literature source (CM5)---

CM5: (1,42 g*225 km + 0,93*1000 + 0,57*225 + 0,33*450 +0,33*450 + 0,25 * 1025 + 0,24*225)/3,37448 g = 588 gkm/g

(CM2+CM3+CM4+CM5)/4 = 3123 gkm/g

About Data

The data is based on information from one German, one Brasilian, one Japanese manufacturer and one literature source containing two useful datasets comparable to three manufacturers. For the manufacturers the information was gathered using a life cycle inventory questionnaire.

All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model.

Of the flows about little more than 63 % are not average values. The flows for Energy input of Electricity, Raw material input of Accelerator, Acetone, Al, Copper, Epoxy resin, Hardener, Pb, PP, Sn, Steel, Zn Emission of Hardener Waste ouput of Al, Copper, Epoxy resin, Hardener, Pb, Sn and Zn are average values.

In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included.

The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. The literature data did not tell if the value has been calculated, measured or estimated.

The result is that approximately 38 % of the flows used in all manufacturers answers were only calculated, 27 % were only estimated, 12 % were measured and calculated, 11 % were only measured, 7 % were a combination of calculations, measurements and estimations, 4 % were first estimated and then calculated.

All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model.

These flows were asked for and no limitations were set for which substances for which they had to account.

Transport description:
Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km).

We here only asked for flows exceeded 2% by weight of the material declaration of the component.
Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes.´

Process description.

	Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gatherd it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Capacitor for surface mounting assembly

Administrative	
Finished	Y
Date Completed	2000-03-08
Copyright	Ericsson
Availability	Official

Technical System	
Name	Capacitor for surface mounting assembly
Functional Unit	One gram capacitor intended for surface mounting
Functional Unit Explanation	The answer from the component manufacturer (CM) is for a family of components. This family is the ceramic multilayer capacitors intended for surface mounting. Within the family the capacitors differs in size, capacitance value, tolerance, type and rated voltage. The environmental load per gram in the final assembly of the capaciors is assumed to be similar. These facts are based on Ericsson technical specification of the component. Ericsson product number: RJC 388, RJC 441 Ericsson description: Ceramic multilayer chip capacitor General information The capacitor is intended for surface mounting.

	Design Multilayer, uncapsulated ceramic chip capacitor Terminations Silver with a nickel barrier layer coated with electroplated tin och tin-lead. Dimensions: Capacitor size 1206 Weight: about 0.03 grams Length: 3.2 +/- 0.3 mm Width: 1.6 +/- 0.25 mm Height: 1.6 mm
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of a capacitor intended for surface mounting. The activity is based on information acquired from one manufacturer. The description of the process is assumed to be general for this type of manufacture. The following process steps are included; 1. Material input 2. Formulation 3. Build-up process 4. Cutting 5. Bisquing 6. Pre-Firing 7. Firing 8. Tumbling 9. Termination 10. Flash/IR 11. Sorting 12. Outgoing Inspection 13. Taping 14. Storage Details given: 1.Material input: Incoming inspection and specific parameter check 2. Formulation: Preparation of paste, enamel and cornstarch basis including parameter check 3. Build-up process: Multilayer shift wet in wet process 4. Cutting: Cutting process + inline inspection 5. Bisquing: Organic burn-out + inspection 6. Pre-Firing: Pre-firing oven 7. Firing: Sintering process in sinter ovens, keeping specific sintering profile 8. Tumbling: The edges of the parts are rounded 9. Termination: Fixing of the termination on the chips, 3 different materials (AgPd, AgPdPt, AgNiSn) 10. Flash/IR: 100 % measurement, voltage resistance (UR) and insulation resistance (IR) 11. Sorting: 100 % automatic sorting in tolerance classes and 100 % measuring of dissipation factor 12. Outgoing Inspection: Final inspection of all electrical, mechanical and visual parameters 13. Taping: Taping in packaging units and inspection tape 14. Storage: Storage - delivery to the customer Internally 0.43 g/g of Solvents, 0,32 g/g Ceramics and 0.0064 g/g of Silver are recycled.

System Boundaries

Nature Boundary	The emissions to air have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impact has been studied. Emissions to water were not reported by the manufacturers.
Time Boundary	1998 The answer from the manufacturer arrived in 1998 and they measured in 1998. The process technology used is most certainly the best available as the factory is located in western Germany and the company is well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturer included in the average is located in Germany.
Other Boundaries	Delimitation's to the system is the final step in the making of the SMD capacitor. The production of the subparts (e.g. ceramic and electrodes) of the resistor is not included in this model The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability.
Allocations	The manufacturers have not described how the allocation has been made.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The data that are presented are calculated based on information from one component manufacturer. The information from the manufacturer was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers In the information supplied by the manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+.+.ACn Step 2: The sum AC11+.+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.)
Literature Reference	One answer on the Ericsson product RJC 388, 441, chip capacitor
Notes	In the flow metadata for specific flows CM stands for component manufacturer.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 2.8 mg/27.94 mg = 0.1 g/g	Input	Refined resource	Ag	0.1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states a use of 2,2 mg. 2,2/27,94 = 0,0787 g/g Polyacrylate assumed to be acrylic paint. Notes: Butyl acetate has CAS-number 123-86-4	Input	Refined resource	Butyl acetate	0.079			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 33 mg/27.94 mg = 1.18 g/g Specified as ceramic powder.	Input	Refined resource	Ceramic	1.18			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states a	Input	Refined resource	Dibutyl phthalate	0.072			g	Technosphere	

use of 2,0 mg. 2,0/27,94 = 0,0716 g/g Notes: Dibutyl phthalate has CAS-number 84-74-2								
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 2,78 Wh / 27,94e-3 g = 99,49 Wh/g The weight of the capacitor is 27.94 mg.	Input	Refined resource	Electricity	99.49		Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states a use of 22 mg. 22/27,94 = 0,787 g/g Notes: ethyl acetate has CAS-number 141-78-6	Input	Refined resource	ethyl acetate	0.79		g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states a use of 3 mg. 3/27,94 = 0,107 g/g Notes: Methoxypropanol has CAS-number1320-67-8	Input	Refined resource	Methoxypropanol	0.11		g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states a use of 2.4 mg solvent naphta. 2.4/27,94 = 0.086 g/g Notes: Naphtha has CAS-number 8030-30-6	Input	Refined resource	Naphtha	0.086		g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 0,29 Wh / 27,94e-3 g = 10,37 Wh/g	Input	Refined resource	Natural gas	10.37		Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 0.18 mg/27.94 mg = 0.0064 g/g	Input	Refined resource	Ni	0.0064		g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 0.16 mg/27.94 mg = 0.0057 g/g	Input	Refined resource	Pd	0.0057		g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states a use of 0,7 mg. 0,7/27,94 = 0,025 g/g	Input	Refined resource	Polyacrylate	0.025		g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 0.26 mg/27.94 mg = 0.0093 g/g	Input	Refined resource	Sn	0.0093		g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states a use of 0,9 mg of other solvents. 0,9/27,94 = 0,0322 g/g	Input	Refined resource	Solvent	0.032		g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Used value: 0,00017895 g/g The weight of the chip capacitor is 27,94 mg according to the producer. The producer states an emission to air of 0,01 mg. 0,01/27,94 = 0,000358 g/g	Output	Emission	Barium Titanate	0.000358		g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states an emission to air of 1,2 mg. 1,2/27,94 = 0,043 g/g	Output	Emission	Butyl acetate	0.043		g	Air	

Date concieved: 1998 Data type: Derived, unspecified Method: CM: 0.01 mg/27.94 mg = 0.00036 g/g	Output	Emission	Ceramic	0.00036			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states an emission to air of 100 mg. 100/27,94 = 3,57 g/g	Output	Emission	CO2	3.57			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states an emission to air of 14 mg. 14/27,94 = 0,50 g/g	Output	Emission	ethyl acetate	0.5			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states an emission to air of 2,8 mg. 2,8/27,94 = 0,1 g/g	Output	Emission	Methoxypropanol	0.1			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip capacitor is 27,94 mg according to the producer. The producer states an emission to air of 0,2 mg. 0,2/27,94 = 0,00716 g/g	Output	Emission	Naphtha	0.0072			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: 1 gram capacitor output is the base for all figures in this model. Capacitors for surface mounting = Life Cycle Inventory model for production of one gram of capacitor intended for surface mounting (applicable to telecommunication equipment)	Output	Product	Capacitor for surface mounting	1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 9 mg/27.94 mg = 0.32 g/g	Output	Residue	Ceramic	0.32			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 43 mg/27.94 mg = 1.54 g/g	Output	Residue	Hazardous waste water	1.54			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 17 mg/27.94 mg = 0.61 g/g	Output	Residue	Solvent	0.61			g	Technosphere	

About Inventory

Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts.

	The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a capacitor manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of SMD capacitors and resembling components in our telecom products. The usage for this set of data is life cycle assessments where capacitors intended for surface mounting are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. --- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to capacitors intended for surface mounting in electronic equipment if you know how much they weigh. -- Transports. -- Here follows a more detailed description of transports of materials and components to the

	manufacturer factory. These transports are not included in the model. CM = Component manufacturer The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport. -- Truck transportation: -- Component manufacturer (CM): Weight of component: 0.02794 g Ceramic with weight 0.033 g is transported 1000 km by road i.e. 0.033 g*1000 km, Metal paste (Ag and Pd) 0.00296 g*700 km, Nickel 0.00018 g*500 km, Tin 0.00026 g*500 km and Solvents 3.5 g*25 km. The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 122.792 gkm/0.02794 g = 4394.85 gkm/g
About Data	The data is based on information from one German manufacturer. The information was gathered using a life cycle inventory questionnaire. The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. 69 % of the flows stated by CM have been just calculated, 21 % have just been measured and 10 have only been estimated. The outline of the LCI data questionnaire that was used in the inventory follows below. No limitations or specifications were set for which substances they had to account. -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes. Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gathered it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (E.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount (mg). Amount In Product (mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production sites (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information.

	Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Cardboard production (MDF based). ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Cardboard production (MDF based). ESA-DBP
Functional Unit	1000 kg of cardboard
Functional Unit Explanation	Unknown
Process Type	Gate to gate
Site	Unknown
Sector	Wood and wooden products excl. Furniture
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''Data for this production represent a Swedish average for production of pulp from newsprint waste''. This process is included in the system described in: Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Manufacturing of CD-R (Compact Disc-Recordable). ESA-DBP - Manufacturing of CD-ROM (Compact Disc - Read Only Memory). ESA-DBP - Dioctyl phthalate (DOP) production. ESA-DBP - Cultivation and felling of trees for papermaking. ESA-DBP - Production of copypaper. ESA-DBP - Production of orthoxylene. ESA-DBP

System Boundaries	
Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials), emissions to air and water.
Time Boundary	1996
Geographical Boundary	Sweden
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData	
Date Conceived	1996
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report: ''To the data from STFI data for average electric energy consumption for drying, rolling and cutting have been added. (Bresky, 1996)''
Literature Reference	Swedish Pulp and Paper Research Institute (STFI) database (1996), Sweden personal communication with Jan Bresky (1996), Stora Research, Sweden
Notes	In the flow metadata for specific flows CM stands for component manufacturer.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Input Product	Newsprint waste	1.20E+03			kg	Technosphere	Sweden
	Input	Refined resource	Biofuel	6.50E+02			MJ	Technosphere	Sweden
	Input	Refined resource	Deinking chemicals	1.30E+04			g	Technosphere	Sweden
	Input	Refined resource	Electricity	1.02E+03			kWh	Technosphere	Sweden
	Input	Refined resource	H2O2	8.00E+03			g	Technosphere	Sweden
	Input	Refined resource	Lime	8.00E+00			kg	Technosphere	Sweden
	Input	Refined resource	NaOH	1.00E+04			g	Technosphere	Sweden
	Input	Refined resource	Oil	4.70E+02			MJ	Technosphere	Sweden
	Input	Refined resource	Sodium silicate	1.50E+04			g	Technosphere	Sweden
	Output	Emission	Ashes	1.01E+04			g	Other	Sweden
	Output	Emission	BOD7	7.30E+02			g	Water	Sweden
	Output	Emission	COD	3.84E+03			g	Water	Sweden
	Output	Emission	N	1.98E+02			g	Water	Sweden
	Output	Emission	Phosphorus	1.00E-02			kg	Water	Sweden
	Output	Emission	Susp solids	4.20E+02			g	Other	Sweden
	Output	Product	Cardboard	1.00E+03			kg	Technosphere	Sweden

About Inventory	
Publication	Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	The study was done for the purpose of master thesis.
Detailed Purpose	Excerpt from the report: ''The goal of this study is to undertake an life cycle assessment (LCA) of different alternatives for Ericsson to provide their customers with reference libraries to the Ericsson Consolo MD110 telephone exchange system. The different documentation alternatives investigated in this study are: plastic ring binders, paperbacks, CD-R records and CD-ROM records.''
Commissioner	Ericsson, Stockholm, Sweden - .
Practitioner	Torsten Beckman - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The inventory results for the whole life cycle (from cradle to grave) of binders, paperbacks, CD-Rs and CD-ROMs can be found in the reference report.

SPINE LCI dataset: Cargo vessel, medium-sized (8´-2´ dwt)

Administrative	
Finished	Y
Date Completed	1998 08
Copyright	NTM
Availability	Public

Technical System	
Name	Cargo vessel, medium-sized (8´-2´ dwt)
Functional Unit	1tonkm
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers, 80 % for RoRo vessles and 60% for other vessles. This is concidered representative for traffic to/from Sweden. *empty trips are included.*
Process Type	Gate to gate
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation of medium sized cargo vessel, 8000-2000 dwt (deadweight tonnes), with a 50% utilisation level for tank cargo and 60% for bulk cargo. Speeds around 13 knots Cargo Vessels include all vessels except RoRo vessels and ferries. Cargo Vessels thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1999.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers, 80% for RoRo vessles and 60% for other vessles 60% (including empty trips) *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1998 - 09
Data Type	Derived, unspecified

Represents	NTM
Method	All vessels larger than 300 tons gross tonnage in the Swedish Shipowners' Association's register have been used as a basis for the data For each individual ship, the load capacity (in dwt), installed engine effect (in kW) (Redareföreningen 1995) and speed (in knots) have been used as a basis. The emissions have been calculated on the basis of the distribution of low and high revolution engines among the different size classes, and the emission factors of the engines (Alexandersson et al 1991), see table below. The energy use has been calculated with the assumption of an oil consumption of 200 g/kWh for both low and medium revolution engines. The emisson factors below are given in g/kWh, where kWh refer to mechanical work done by the engine. Engine type Load NOx CO CO2 THC PM Low rev 80% 17,7 0,2 600 0,8 0,9 Medium rev 80% 14 1 620 0,2 0,4 The utilisation levels used in these calculations are as follows: Tank 0,5 Bulk 0,6 RoRo 0,8 LoLo 0,6 Ferry 0,6 Others 0,6 The calculations of emissions from shipping are made according to the following principle: emission factor = spec.emission x effect x 1 x 1 speed load capacity utilisation level The *quantity value* for all parameters is an average of all vessels in the population. The *minimum value* corresponds to the individual with the lowest energy use and emissions in the population, and the *maximum value* to the individual with the largest energy use and emissions in the population.
Literature Reference	-Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Demker, G. et al. *Miljöeffekter av transportmedelsval för godstransporter*, MariTerm, KFB-rapport, 1994:6 *Skeppsregister 1995*, Swedish Shipowner Association Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 *Lloyds list*, 1996
Notes	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Heavy oil	0.078	0.040	0.111	kWh	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	0.025	0.011	0.039	g	Air	Sweden
	Output	Emission	CO2	21	11	31	g	Air	Sweden
	Output	Emission	HC	0.015	0.0062	0.030	g	Air	Sweden
	Output	Emission	NOx	0.54	0.27	0.75	g	Air	Sweden
	Output	Emission	Particles	0.020	0.0094	0.034	g	Air	Sweden
	Output	Emission	SO2	0.36	0.19	0.52	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation

Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Sörheim, Elisabet - Swedish Shipowners Association .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vessel, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association or from the operators. ***Type of vessels*** *Cargo Vessles* - includes all vessels except RoRo vessels and ferries. Cargo Vessles thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc. Cargo Vessles are mainly used for transportation of heavy goods over large distances. The energy use for tankers is generally lower than for other Cargo vessles. *RoRo vessels* are used for transportation of different types of load carriers such as trailers, containers etc. The cargo is rolled on the vessel. RoRo vessels generally operate at a higher speed than regular Cargo vessles. *Ferries* carry both passengers and goods. The goods are carried in trucks, trailers or trains. ***Fuel*** The fuel quality vary to a large extent between different vessels. Smaller vessels that only operate on Swedish routes generally use cleaner fuels. The main part of freighters in Swedish traffic use heavy fuel oil, with a sulphur content of 2,6 %. Small coastal freighters may however use gas oil with sulphur content of 0,1 %. Gas oil is the most refined type of fuel used in vessels (the maximum sulphur content is 1,5 %). In ferries, low sulphur fuel with sulphur content of 0,5 % is generally used. ***Reduction of emissions*** The data does not assume the use of any emission reducing measures. Different measures may be taken to reduce the emissions, e.g. water injection may reduce the emissions of NOx by 50%, and adjustments of the engine may reduce NOx emissions by 30 %. Catalytic converters may reduce NOx emissions by 90-100% and HC by 70-80%. Emissions of particles and HC are also reduced. Installation of catalytic converters is however a large investment for the shipowners. There are at present only a few vessels in Swedish traffic that has installed catalytic converters. The other measures constitute a smaller investment, and it is anticipated that the shipowners will chose these techniques to reduce emissions. ***Bulky goods*** Vessels generally handle transportation of large heavy goods over long distances. Some bulky goods are however transported by sea, primarily by RoRo vessels and ferries. The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Travelled distance*** The travelled distance of the goods may be estimated using a Nautic almanac, Lloyd. Since the utilisation level includes empty trips, no compensation in the distance for empty trips needs to be done. ***International sea transports*** When using the data for international traffic, the sulphur emissions should be adjusted, since the fuel quality may vary. Representative sulphur content of fuel used in international traffic is 3,3 %. The energy use and emissions of other parameters may also vary to a large extent depending on the quality of the fuel. The utilisation levels used in these calculations are as follows: Tank 0,5 Bulk 0,6

	RoRo 0,8 LoLo 0,6 Ferry 0,6 Others 0,6
About Data	Data have been calculated on the basis of the load capacity (in dwt), installed engine effect (in kW) (Redareföreningen) and speed (in knots) (Lloyds) of each individual ship. Emissions to air per tonkm have been calculated by using the emission factors of the engines (Alexandersson et.al. 1991), see table below, and by knowing the relation of low and medium revolution engines to different sizes of ships. The emisson factors below are given in g/kWh, where kWh refer to mechanical work done by the engine. Engine type Load NOx CO CO2 THC PM Low rev 80% 17,7 0,2 600 0,8 0,9 Medium rev 80% 14 1 620 0,2 0,4 The energy consumption has been calculated by the assumption of an oil consumption of 200g/kWh for both low and medium revolution engines. The sulphurous content of the fuel is assumed to be 2.6% for cargo-ships (Sjöbris 1994).
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by boat in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Cargo vessel, small (<2´dwt)

Administrative	
Finished	Y
Date Completed	1998 08
Copyright	NTM
Availability	Public

Technical System	
Name	Cargo vessel, small (<2´dwt)
Functional Unit	1 tonkm
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers, 80 % for RoRo vessles and 60% for other vessles. This is concidered representative for traffic to/from Sweden. *empty trips are included.*
Process Type	Gate to gate
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation of small cargo vessel, including vessels smaller than 2000 dwt (deadweight tonnes), with a 50% utilisation level for tank cargo and 60% for bulk cargo. Speeds around 11 knots Cargo vessels include all vessels except RoRo vessels and ferries. Cargo Vessels thus include a large variety of different vessels; tankers, container ships,

	LoLo vessels, bulk vessels, vessels built for a special route etc.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1999.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers, 80% for RoRo vessles and 60% for other vessles 60% (including empty trips) *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 09
Data Type	Derived, unspecified
Represents	NTM
Method	All vessels larger than 300 tons gross tonnage in the Swedish Shipowners' Association's register have been used as a basis for the data For each individual ship, the load capacity (in dwt), installed engine effect (in kW) (Redareföreningen 1995) and speed (in knots) have been used as a basis. The emissions have been calculated on the basis of the distribution of low and high revolution engines among the different size classes, and the emission factors of the engines (Alexandersson et al 1991), see table below. The energy use has been calculated with the assumption of an oil consumption of 200 g/kWh for both low and medium revolution engines. The emisson factors below are given in g/kWh, where kWh refer to mechanical work done by the engine. Engine type Load NOx CO CO2 THC PM Low rev 80% 17,7 0,2 600 0,8 0,9 Medium rev 80% 14 1 620 0,2 0,4 The utilisation levels used in these calculations are as follows: Tank 0,5 Bulk 0,6 RoRo 0,8 LoLo 0,6 Ferry 0,6 Others 0,6 The calculations of emissions from shipping are made according to the following principle: emission factor = spec.emission x effect x 1 x 1 speed load capacity utilisation level The *quantity value* for all parameters is an average of all vessels in the population. The *minimum value* corresponds to the individual with the lowest energy use and emissions in the population, and the *maximum value* to the individual with the largest energy use and emissions in the population.
Literature Reference	-Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Demker, G. et al. *Miljöeffekter av transportmedelsval för godstransporter*, MariTerm, KFB-rapport, 1994:6 *Skeppsregister 1995*, Swedish Shipowner Association Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 *Lloyds list*, 1996
Notes	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Heavy oil	0.11	0.044	0.19	kWh	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

	Output	Emission	CO	0.0417	0.0155	0.0840	g	Air	Sweden
	Output	Emission	CO2	30.4	12.3	52.9	g	Air	Sweden
	Output	Emission	HC	0.016	0.0074	0.023	g	Air	Sweden
	Output	Emission	NOx	0.725	0.301	1.20	g	Air	Sweden
	Output	Emission	Particles	0.0245	0.0108	0.0350	g	Air	Sweden
	Output	Emission	SO2	0.513	0.208	0.887	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Sörheim, Elisabet - Swedish Shipowners Association .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vessel, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association or from the operators. ***Type of vessels*** *Cargo Vessles* - includes all vessels except RoRo vessels and ferries. Cargo Vessles thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc. Cargo Vessles are mainly used for transportation of heavy goods over large distances. The energy use for tankers is generally lower than for other Cargo vessles. *RoRo vessels* are used for transportation of different types of load carriers such as trailers, containers etc. The cargo is rolled on the vessel. RoRo vessels generally operate at a higher speed than regular Cargo vessles. *Ferries* carry both passengers and goods. The goods are carried in trucks, trailers or trains.

Fuel
The fuel quality vary to a large extent between different vessels. Smaller vessels that only operate on Swedish routes generally use cleaner fuels. The main part of freighters in Swedish traffic use heavy fuel oil, with a sulphur content of 2,6 %. Small coastal freighters may however use gas oil with sulphur content of 0,1 %. Gas oil is the most refined type of fuel used in vessels (the maximum sulphur content is 1,5 %). In ferries, low sulphur fuel with sulphur content of 0,5 % is generally used.

Reduction of emissions
The data does not assume the use of any emission reducing measures. Different measures may be taken to reduce the emissions, e.g. water injection may reduce the emissions of NOx by 50%, and adjustments of the engine may reduce NOx emissions by 30 %. Catalytic converters may reduce NOx emissions by 90-100% and HC by 70-80%. Emissions of particles and HC are also reduced. Installation of catalytic converters is however a large investment for the shipowners. There are at present only a few vessels in Swedish traffic that has installed catalytic converters. The other measures constitute a smaller investment, and it is anticipated that the shipowners will chose these techniques to reduce emissions.

Bulky goods
Vessels generally handle transportation of large heavy goods over long distances. Some bulky goods are however transported by sea, primarily by RoRo vessels and ferries. The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Travelled distance
The travelled distance of the goods may be estimated using a Nautic almanac, Lloyd. Since the utilisation level includes empty trips, no compensation in the distance for empty trips needs to be done.

International sea transports
When using the data for international traffic, the sulphur emissions should be adjusted, since the fuel quality may vary. Representative sulphur content of fuel used in international traffic is 3,3 %. The energy use and emissions of other parameters may also vary to a large extent depending on the quality of the fuel.

The utilisation levels used in these calculations are as follows:

Tank 0,5
Bulk 0,6
RoRo 0,8
LoLo 0,6
Ferry 0,6
Others 0,6

About Data

Data have been calculated on the basis of the load capacity (in dwt), installed engine effect (in kW) (Redareföreningen) and speed (in knots) (Lloyds) of each individual ship. Emissions to air per tonkm have been calculated by using the emission factors of the engines (Alexandersson et.al. 1991), see table below, and by knowing the relation of low and medium revolution engines to different sizes of ships.

The emisson factors below are given in g/kWh, where kWh refer to mechanical work done by the engine.
Engine type Load NOx CO CO2 THC PM
Low rev 80% 17,7 0,2 600 0,8 0,9
Medium rev 80% 14 1 620 0,2 0,4

The energy consumption has been calculated by the assumption of an oil consumption of 200g/kWh for both low and medium revolution engines.

The sulphurous content of the fuel is assumed to be 2.6% for cargo-ships (Sjöbris 1994).

Notes

The person stated as ''Practitioner'' is the contact person for the data for transportation by boat in NTM.

The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation.

The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives.

The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Cargo vessels, large (>8´ dwt)

Administrative	
Finished	Y
Date Completed	1998 08
Copyright	NTM
Availability	Public

Technical System	
Name	Cargo vessels, large (>8´ dwt)
Functional Unit	1 tonkm
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers, 80 % for RoRo vessles and 60% for other vessles. This is concidered representative for traffic to/from Sweden. *empty trips are included.*
Process Type	Gate to gate
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation of large cargo-ship, including vessels larger than 8000 dwt (deadweight tonnes), (max. 280 000 dwt) with a 50% utilisation level for tank cargo and 60% for bulk cargo. Speeds around 14 knots Cargo vessels include all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1999.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers, 80% for RoRo vessles and 60% for other vessles 60% (including empty trips) *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1998 - 09
Data Type	Derived, unspecified

Represents	NTM
Method	All vessels larger than 300 tons gross tonnage in the Swedish Shipowners' Association's register have been used as a basis for the data For each individual ship, the load capacity (in dwt), installed engine effect (in kW) (Redareföreningen 1995) and speed (in knots) have been used as a basis. The emissions have been calculated on the basis of the distribution of low and high revolution engines among the different size classes, and the emission factors of the engines (Alexandersson et al 1991), see table below. The energy use has been calculated with the assumption of an oil consumption of 200 g/kWh for both low and medium revolution engines. The emisson factors below are given in g/kWh, where kWh refer to mechanical work done by the engine. Engine type Load NOx CO CO2 THC PM Low rev 80% 17,7 0,2 600 0,8 0,9 Medium rev 80% 14 1 620 0,2 0,4 The utilisation levels used in these calculations are as follows: Tank 0,5 Bulk 0,6 RoRo 0,8 LoLo 0,6 Ferry 0,6 Others 0,6 The calculations of emissions from shipping are made according to the following principle: emission factor = spec.emission x effect x 1 x 1 speed load capacity utilisation level The *quantity value* for all parameters is an average of all vessels in the population. The *minimum value* corresponds to the individual with the lowest energy use and emissions in the population, and the *maximum value* to the individual with the largest energy use and emissions in the population.
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Demker, G. et al. *Miljöeffekter av transportmedelsval för godstransporter*, MariTerm, KFB-rapport, 1994:6 *Skeppsregister 1995*, Swedish Shipowner Association Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 *Lloyds list*, 1996
Notes	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Heavy oil	0.056	0.014	0.083	kWh	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	0.00860	0.00130	0.0147	g	Air	Sweden
	Output	Emission	CO2	15.1	3.88	22.6	g	Air	Sweden
	Output	Emission	HC	0.017	0.0052	0.028	g	Air	Sweden
	Output	Emission	NOx	0.427	0.115	0.650	g	Air	Sweden
	Output	Emission	Particles	0.0203	0.0058	0.0319	g	Air	Sweden
	Output	Emission	SO2	0.261	0.0670	0.390	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation

Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Sörheim, Elisabet - Swedish Shipowners Association .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vessel, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association or from the operators. ***Type of vessels*** *Cargo Vessles* - includes all vessels except RoRo vessels and ferries. Cargo Vessles thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc. Cargo Vessles are mainly used for transportation of heavy goods over large distances. The energy use for tankers is generally lower than for other Cargo vessles. *RoRo vessels* are used for transportation of different types of load carriers such as trailers, containers etc. The cargo is rolled on the vessel. RoRo vessels generally operate at a higher speed than regular Cargo vessles. *Ferries* carry both passengers and goods. The goods are carried in trucks, trailers or trains. ***Fuel*** The fuel quality vary to a large extent between different vessels. Smaller vessels that only operate on Swedish routes generally use cleaner fuels. The main part of freighters in Swedish traffic use heavy fuel oil, with a sulphur content of 2,6 %. Small coastal freighters may however use gas oil with sulphur content of 0,1 %. Gas oil is the most refined type of fuel used in vessels (the maximum sulphur content is 1,5 %). In ferries, low sulphur fuel with sulphur content of 0,5 % is generally used. ***Reduction of emissions*** The data does not assume the use of any emission reducing measures. Different measures may be taken to reduce the emissions, e.g. water injection may reduce the emissions of NOx by 50%, and adjustments of the engine may reduce NOx emissions by 30 %. Catalytic converters may reduce NOx emissions by 90-100% and HC by 70-80%. Emissions of particles and HC are also reduced. Installation of catalytic converters is however a large investment for the shipowners. There are at present only a few vessels in Swedish traffic that has installed catalytic converters. The other measures constitute a smaller investment, and it is anticipated that the shipowners will chose these techniques to reduce emissions. ***Bulky goods*** Vessels generally handle transportation of large heavy goods over long distances. Some bulky goods are however transported by sea, primarily by RoRo vessels and ferries. The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Travelled distance*** The travelled distance of the goods may be estimated using a Nautic almanac, Lloyd. Since the utilisation level includes empty trips, no compensation in the distance for empty trips needs to be done. ***International sea transports*** When using the data for international traffic, the sulphur emissions should be adjusted, since the fuel quality may vary. Representative sulphur content of fuel used in international traffic is 3,3 %. The energy use and emissions of other parameters may also vary to a large extent depending on the quality of the fuel. The utilisation levels used in these calculations are as follows: Tank 0,5 Bulk 0,6

	RoRo 0,8 LoLo 0,6 Ferry 0,6 Others 0,6
About Data	Data have been calculated on the basis of the load capacity (in dwt), installed engine effect (in kW) (Redareföreningen) and speed (in knots) (Lloyds) of each individual ship. Emissions to air per tonkm have been calculated by using the emission factors of the engines (Alexandersson et.al. 1991), see table below, and by knowing the relation of low and medium revolution engines to different sizes of ships. The emisson factors below are given in g/kWh, where kWh refer to mechanical work done by the engine. Engine type Load NOx CO CO2 THC PM Low rev 80% 17,7 0,2 600 0,8 0,9 Medium rev 80% 14 1 620 0,2 0,4 No test cycle was used to obtain the emission factors. There is however a small need for test cycles, since vessels generally operate at constant load on the engine during the sail. The fact that the engine load sometimes is lower than 80 % i.e. when sailing to and from the harbour has been neglected. This part is generally small but complicated. The calculation model may be used to calculate the energy use and emissions for a specific vessel if the loading capacity, installed engine power etc. is known. This information may be obtained from Skeppsregister. See QMetaData for details. The energy consumption has been calculated by the assumption of an oil consumption of 200g/kWh for both low and medium revolution engines. The sulphurous content of the fuel is assumed to be 2.6% for cargo-ships (Sjöbris 1994).
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by boat in NTM. The person stated as ''Practitioner'' is the contact person for the data for transportation by boat in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Cast iron production. ESA-DBP

Administrative	
Finished	Y
Date Completed	1996
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Cast iron production. ESA-DBP
Functional Unit	1 kg of cast iron
Functional Unit Explanation	Unknown
Process Type	Gate to gate
Site	Unknown

Sector	Manufacturing
Owner	Unknown
Technical system description	Cast iron is produced in the foundry. Excerpt from the report, see 'Publication': ''The furnace under study in this LCA is the Swan Foundry. In the foundry and electric arc furnace is used to melt together the input of pig iron, external and internal scrap. The output from the electric arc furnace is poured into a mould or a core. The pattern used is made of wood, resin or metal. For the mould making the CO2-silicate process is used. The CO2 - silicate acts like a binder in the moulding. After the process of moulding the components goes through a finishing which consists of shot-blasting, fettling and painting. The emissions from the foundry are from the electric arc furnace. The emission of particulates (...) is data from an uncontrolled furnace with a melt of alloy steel. (...) The scrap reclaimed internally by the foundry are returned to the electrical furnace and therefore not emitting any extra emissions.'' This process is included in the system described in: Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Coal mining and cleaning. ESA-DBP - Limestone quarrying. ESA-DBP - Sand extraction and processing. ESA-DBP - Sinter plant's process ESA-DBP - Uranium ore extraction and enrichment. ESA-DBP - Production of pig iron - blast furnace process. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) and emissions to air.
Time Boundary	Data for emissions come from 1986 and the rest from 1996.
Geographical Boundary	United Kindom
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1986-1996
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other report.
Literature Reference	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Data for particular process come from: Hughes D.(1996), Swan Foundry (Banbury) Ltd., Swan Close Road, Banbury, Oxon OX16 8AL, England. personal communication. United Nations Environment Programme (UNEP) (1986), Environmental Aspects of Iron and Steel Production, A Technical Review, Industry & Environment Office.
Notes	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	CO2	1.12E-01			kg	Technosphere	United Kingdom
	Input	Refined resource	Electricity	1.80E-01			MJ	Technosphere	United Kingdom
	Input	Refined resource	Foundry scrap	9.00E-02			kg	Technosphere	United Kingdom
	Input	Refined resource	Pig iron	1.10E-01			kg	Technosphere	United Kingdom

	Input	Refined resource	Reclaimed sand	1.07E+00			kg	Technosphere	United Kingdom
	Input	Refined resource	Sand	6.10E-01			kg	Technosphere	United Kingdom
	Input	Refined resource	Scrap-iron	8.90E-01			kg	Technosphere	United Kingdom
Notes: Na2CO3	Input	Refined resource	Sodium carbonate	2.00E-01			kg	Technosphere	United Kingdom
	Output	Emission	CO	1.00E-03			kg	Air	United Kingdom
	Output	Emission	Particulates	2.54E-02			kg	Air	United Kingdom
	Output	Product	Cast iron	1.00E+00			kg	Technosphere	United Kingdom

About Inventory	
Publication	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The aim of the study is to undertake an LCA of typical water and sewage pumps. Those aspects which have a major contribution to the environmental impact in the life cycle of a pump will be identified.''
Detailed Purpose	Cast iron is a main material in a water pump (90%).
Commissioner	Unknown - .
Practitioner	Johanna Thuresson - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Casting of iron, type V10

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Casting of iron, type V10
Functional Unit	6,59 kg cast iron
Functional Unit Explanation	6,59 kg cast iron is used to produce one bearing housing, SNL 511-609, at SKF Mekan AB in Katrineholm. Much of the data in this activity is taken from the LCA of the bearing housing SNL 511-609, and thus it was more convenient to keep their functional unit although new data also is collected. The figure 6,59 has nothing to do with guide rings as such. The guide ring will be used in the spherical roller bearing 232/530 at SKF, Göteborg.

Process Type	Unit operation
Site	SKF Mekan ABBox 89 641 21 Katrineholm
Sector	Materials and components
Owner	SKF Mekan ABBox 89 641 21 Katrineholm
Technical system description	This activity describes a process step included in the whole system activity ''Production of guide rings used for spherical roller bearings'', also available in the SPINE@CPM database. The guide ring is manufactured at SKF Mekan AB in Katrineholm and the process consists of several steps. See the activity ''Production of guide rings used for spherical roller bearings'' for details. The guide ring will finally be mounted into the SKF Spherical Roller Bearing 232/530. The function of the guide ring is to assure that the rollers stay in the raceways of the bearing. The guide ring is made of cast iron, produced mainly from scrap. After smelting of the raw materal the smelt iron is casted in a sand form. The cast iron is then further processed into guide rings. This data set describes the casting process: In the casting process the guide rings are formed into a desired shape. A sand form is used, that in this case is a Novaset sand system. The Novaset sand system consists of a forming mass that is self-stiffened: 15,65 kg sand 0,151 kg Novaset 400 0,044 kg Hardener 4030 When the form is rigid it is treated with isopropanol in order to make the surface tight. The smelt is then poured into the form and after the smelt has become hard enough, the formed is cracked. The Novaset sand is transported as non hazardous waste to a deposit. Some of the data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.

System Boundaries

Nature Boundary	Many of the chemicals used in the process are not followed from the cradle, since it was too time consuming and the impact was assumed to be very small since the total amount was small and the substances according to product data sheets not were considered hazardous. These inflows are considered non-elementary and come from the technosphere. The Novaset sand is transported as non hazardous waste to a deposit and are thus followed to nature. Many other outflows are considered non-elementary and go to the technosphere, since it was too time consuming to follow them to the grave.
Time Boundary	The dat was collected during autumn 2002 and no changes for the procedure are planned for the nearest future.
Geographical Boundary	The casting process takes place at SKF Mekan AB in Katrineholm, Sweden.
Other Boundaries	The production of Electricity and District heat are NOT included in the dataset and must be followed from the cradle in order to obtain the total environmental impact. The sand used for the sand form should also be traced from the cradle. The activity ''Production of quartz sand'' is available in the SPINE@CPM database.
Allocations	Allocations have been made according to weight in this specific production line at SKF Mekan AB in Katrineholm
Systems Expansions	Not Applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'
Method	Data has been gathered from interviews and supplied material from Marja Andersson, SKF Mekan AB, in Katrineholm. She is responsible for environmental questions and much of the data comes from the environmental report from year 2001.
Literature Reference	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Data for particular process come from: Hughes D.(1996), Swan Foundry (Banbury) Ltd., Swan Close Road, Banbury, Oxon OX16 8AL, England. personal communication. United Nations Environment Programme (UNEP) (1986), Environmental Aspects of Iron and Steel Production, A Technical Review, Industry & Environment Office.

Notes	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Absol	0.0023			kg	Technosphere	
	Input	Refined resource	Al	1.13E-4			kg	Technosphere	
	Input	Refined resource	Ba	1.13E-4			kg	Technosphere	
	Input	Refined resource	BL AIR set	0.000938			kg	Technosphere	
	Input	Refined resource	Ca	1.13E-4			kg	Technosphere	
	Input	Refined resource	Dimatrenn SL	1.76e-5			l	Technosphere	
	Input	Refined resource	District heat	844699			J	Technosphere	
	Input	Refined resource	Electricity	4.98e6			J	Technosphere	
	Input	Refined resource	i-Propanol	0.00488			kg	Technosphere	
	Input	Refined resource	Iron	6.590			kg	Technosphere	
	Input	Refined resource	Isofrax	5.52e-007			m2	Technosphere	
	Input	Refined resource	Kermag EN 95	5.63e-6			kg	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Monitored data, continuous Method: Data from Marja Andersson and the product data sheet. Notes: Novaset400 contains according to the product data sheet: Metanol < 3 % Kaliumhydroxid 5-15 % Formaldehyd 0,2<1 % Fenol < 1,6 %	Input	Refined resource	Novaset400	0.151			kg	Technosphere	
	Input	Refined resource	Sand	15.65			kg	Technosphere	
	Input	Refined resource	Si	7.1E-3			kg	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Monitored data, continuous Notes: Triacetin is also called Hardener 3040.	Input	Refined resource	Triacetin	0.044			kg	Technosphere	
	Output	Emission	Aerosols	1.65e-005			kg	Air	
	Output	Emission	Particles	4.86e-4			kg	Air	
Date concieved: 02-08-01 - 02-12-31 Data type: Unspecified, guesstimate Method: Marja Andersson, responsible for environmental questions at SKF Mekan AB in Katrineholm, Sweden, estimated that the emissions of VOC is the same amount as the amont of inflow of isopropanol in the process. 1:1.	Output	Emission	VOC	0.00488			kg	Air	
	Output	Product	Cast iron	6.59			kg	Technosphere	
	Output	Residue	Disposal waste	0.00564			kg	Ground	Sweden
	Output	Residue	glugol	0.000183			kg	Technosphere	Sweden
	Output	Residue	Grease	5e-005			kg	Technosphere	
	Output	Residue	Industrial	0.00013			kg	Technosphere	Sweden
	Output	Residue	krymp och sträckfilm	0.00027			kg	Technosphere	Sweden
	Output	Residue	Oil	4.65			g	Technosphere	Sweden
	Output	Residue	Oil Emulsion	0.1239			g	Technosphere	Sweden
	Output	Residue	Other paper	0.0016			kg	Technosphere	Sweden
	Output	Residue	Paper	0.000764			kg	Technosphere	Sweden
	Output	Residue	Particles	0.289			kg	Technosphere	

	Output	Residue	Solid	15.8			kg	Technosphere	
	Output	Residue	solvent	7.47e-005			kg	Technosphere	Sweden
	Output	Residue	Waste Incinerated	0.00677			kg	Technosphere	Sweden

About Inventory	
Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for casting of smelted iron (type V10) at the specific site at SKF Mekan AB in Katrineholm, Sweden.
About Data	Data is gathered from interviews with Marja Andersson, SKF Mekan AB, Katrineholm. Some of the data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	

SPINE LCI dataset: CBG combustion in heavy duty truck or bus, spark ignition engine, Euro V, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	CBG combustion in heavy duty truck or bus, spark ignition engine, Euro V, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of CBG to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	

Technical system description	The data represent emissions from compressed biogas (CBG) combustion in heavy duty truck or bus with a spark ignition (SI) engine, Euro V, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on ETC (transient test cycle for truck and bus engines), legislation limits for Euro V (2005/55/EC). The ETC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.40 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of N2O was best estimate.
Literature Reference	Main references: (1) 2005/55/EC (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) SS 15 54 38 (5) FordonsGas Sverige AB, Mattias Johansson, personal communication.
Notes	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Product	Compressed biogas (CBG)	1			MJ	Technosphere	
Method: The fossil carbon content is per definition zero. Literature:	Output	Emission	Carbon dioxide (fossil)	0			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Carbon monoxide	4.44444444444444E-04			kg	Air	

Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Methane	1.22222222222222E-04			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Nitrogen oxides	2.22222222222222E-04			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	5.55555555555556E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Non-methane volatile organic compounds	6.11111111111111E-05			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Particles (unspecified)	3.33333333333333E-06			kg	Air	
Method: A conservative value since the legislation for vehicle gas based on biogas has a limit of 20 ppm sulphur in Sweden (SS 15 54 38) . 1 kg sulphur causes 2 kg SO2. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 46.95 MJ/kg (FordonsGas Sverige AB). Literature: A conservative value	Output	Emission	Sulfur dioxide	8.51970181043663E-07			kg	Air	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: CBG combustion in heavy duty truck or bus, spark ignition engine, Euro VI, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	CBG combustion in heavy duty truck or bus, spark ignition engine, Euro VI, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of CBG to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from compressed biogas (CBG) combustion in heavy duty truck or bus with a spark ignition (SI) engine, Euro V, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	See 'Function'
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on WHTC (World Harmonized Transient Cycle for truck and bus engines), legislation limits for Euro VI (Commission Regulation (EC) No 582/2011).The WHTC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for

	fuel use: Efficiency: 0.40 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of N2O was best estimate.
Literature Reference	Main references: (1) Commission Regulation (EC) No 582/2011 (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) SS 15 54 38 (5) FordonsGas Sverige AB, Mattias Johansson, personal communication.
Notes	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Product	Compressed biogas (CBG)	1			MJ	Technosphere	
Method: The fossil carbon content is per definition zero. Literature:	Output	Emission	Carbon dioxide (fossil)	0			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Carbon monoxide	4.44444444444444E-04			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Methane	5.55555555555556E-05			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Nitrogen oxides	5.11111111111111E-05			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	5.55555555555556E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Non-methane volatile organic compounds	1.77777777777778E-05			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Particles (unspecified)	1.11111111111111E-06			kg	Air	
Method: A conservative value since the legislation for vehicle gas based on biogas has a limit of 20 ppm sulphur in Sweden (SS 15 54 38) . 1 kg sulphur causes 2 kg SO2.	Output	Emission	Sulfur dioxide	8.51970181043663E-07			kg	Air	

The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 46.95 MJ/kg (FordonsGas Sverige AB). Literature: A conservative value									

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Cement production

Administrative	
Finished	Y
Date Completed	1997-05-01
Copyright	
Availability	Public

Technical System	
Name	Cement production
Functional Unit	kg
Functional Unit Explanation	1 kg cement
Process Type	Cradle to gate
Site	Cementa AB Box 33 541 21 Skövde Sweden
Sector	Materials and components
Owner	Cementa AB Box 33 541 21 Skövde Sweden
Technical system description	The production process of cement can be divided in five stages: 1. Mining of limestone 2. Grinding of limestone and other raw materials to raw meal 3. Burning of raw meal to clinker 4. Grinding of clinker to cement 5. Storage, dispatch of cement Mining of limestone The limestone is mined out from open quarries and mines. The limestone is crushed and transported to storage facilities.

	Grinding of limestone and other raw materials to raw meal The raw materials (crushed limestone, quartzite, bauxite, iron oxide, gypsum etc.) are stored in separate raw material hoppers before they are fed in to the raw meal mills. The raw meal is then transported to silos for storage and homogenisation. Depending on the specifications of the clinker and the cement, raw meal can be made in different qualities. Burning of raw meal to clinker The clinker production takes place in a rotary kiln where the temperature of the materials reaches up to 1450°C. In this process the grins are sintered together into small balls - the clinker. The clinker is cooled in air-coolers before transport to silos for storage. According to the specifications of the cement, different qualities of clinker are made. Coal and petcoke are normally used as fuel for the rotary kilns, but also other types of fossil fuel can be used. In the Nordic and some other countries, waste and hazardous waste derived fuels are used, which then replace some of the fossil fuels. Grinding of clinker to cement The clinker is ground in cement mills together with 3-7% gypsum which is added to control the setting time. Other additives such as limestone, fly ash and blastfurnace slag may be added in the grinding to modify the cement properties or to produce special qualities of cement. Storage, dispatch of cement After the grinding process the cement is conveyed to storage silos. Some cement is bagged.

System Boundaries

Nature Boundary	Emissions from the extraction and combustion of energy carriers is included. The area is not considered in this set of data. Noise is not considered. Note: Björklund interpreted the study from Stiftelsen Östfoldsforskning (STÖ) that was used as a basis for this data, that emissions from extraction and combustion of energy carriers are included. It is however not very clear, in Björklund or in the report from STÖ, that this actually is the case. See also About Data for a description of the alterations of system boundaries that has been made on the study from STÖ, to obtain the data that is presented.
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	Explosives, grind media, iron-sulfate, waste-oil and electricity are accounted for as non-elementary flows, i.e. not followed back to the cradle.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1995-01-01
Data Type	Unspecified
Represents	See 'Function'
Method	Inventory has been performed by Stiftelsen Østfoldforskning (STØ), Norway during 1995 (Vold), but has been altered by Chalmers University of Technology, Sweden to comply with the frame work of the study. The data is presented in Table 5.2 in Björklund Tillman See ''About Data'' for details on the alterations that has been perfomed
Literature Reference	Vold M., RÆnning, LCA of cement and concrete - Main report, STÆ (Stiftelsen Æstfoldforskning), Fredriksstad, 1995.
Notes	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Additives	9.291			g	Other	

	Input	Natural resource	Coal	0.861			MJ	Other	
	Input	Natural resource	Coal	31.65			g	Other	
	Input	Natural resource	Coke	1.523			MJ	Other	
	Input	Natural resource	Coke	38.075			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Diesel	0.058			MJ	Other	
	Input	Natural resource	Fossil fuel	0.925			MJ	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Gypsum	45.81			g	Other	
	Input	Natural resource	Heavy oil (eo5)	0.207			MJ	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Limestone	1361			g	Other	
	Input	Natural resource	Quartzite	46.109			g	Other	
	Input	Natural resource	Waste fossil fuel	0.533			MJ	Other	
	Input	Refined resource	Electricity	0.47			MJ	Technosphere	
	Input	Refined resource	Explosives	0.272			g	Technosphere	
	Input	Refined resource	Grind media	0.091			g	Technosphere	
	Input	Refined resource	Iron sulphate	9.2			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Waste oil	0.016			MJ	Technosphere	
	Input	Refined resource	Waste oil	12.423			g	Technosphere	
	Output	Emission	Ashes	0.002			g	Ground	
	Output	Emission	Cd	0.0000104			g	Air	
	Output	Emission	CH4	0.305			g	Air	
	Output	Emission	CO	0.784			g	Air	
	Output	Emission	CO2	805.595			g	Air	
	Output	Emission	COD	0.0000867			g	Water	
	Output	Emission	Cr	0.000017			g	Air	
	Output	Emission	Cu	0.00000257			g	Air	
	Output	Emission	HC	0.016			g	Air	
	Output	Emission	Hg	0.00000349			g	Air	
	Output	Emission	N2O	0.000000146			g	Air	
	Output	Emission	NOx	1.936			g	Air	
	Output	Emission	N-tot	0.0000142			g	Water	
	Output	Emission	Oil (aq)	0.0000297			g	Water	
	Output	Emission	PAH	0.000000336			g	Air	
	Output	Emission	Particles	0.162			g	Air	
	Output	Emission	Pb	0.00000868			g	Air	
	Output	Emission	Phenol	0.000000423			g	Air	
	Output	Emission	SO2	0.451			g	Air	
	Output	Emission	Tl	0.000104			g	Air	
	Output	Emission	VOC	0.129			g	Air	
	Output	Emission	Zn	0.0000129			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Product	Cement	1			kg	Technosphere	

About Inventory

Publication	LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund, Tillman; Report 1997:2; TEP; CTH; Göteborg; Sweden -- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology --
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural wooden and concrete frames in buildings during the whole life-cycle, by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of cement
Commissioner	- Finncement Finland .
Practitioner	Björklund Thomas, Tillman Anne-Marie - Technical Environmental Planning, CTH 412 96 Göteborg Sweden.
Reviewer	
Applicability	These data are according to Öberg M. (Cementa in Danderyd, Sweden, 1995) representative for an average Nordic cement production. Most of the cement is dispatched from the factory in bulk by ship and lorries.
About Data	The transport distance for cement from storage to customer is 160-250 km, which is not included in this set of data. The inventory data is based on an earlier study performed by Stiftelsen Östfoldforskning (STÖ). The inventory calculation in the STÖ study has however been altered to comply with the framework of this study, performed at Chalmers University of Technology (CTH). The following is a list of the alterations that has been done at CTH of inventory data from STÖ (transcript from Björklund et. al. Table 5.1) ---Type of cement production:--- CTH: only data from the production at the plant in Skövde is used STÖ: three plants in Sweden are analysed ---Energy:--- CTH: Electricity without emission factors is used STÖ: Norwegian and Swedish average energy is used CTH: The energy carrier ''Coke, mie'' is substituted with coke with no emission factors STÖ:''Coke, mie'' is the name of an energy carrier that is not available at CTH CTH: The energy carrier ''Fossil fuel'' is substituted with the use of fossil fuel without emission factor. STÖ: The energy carrier ''Fossil fuel'' is the name of an energy carrier that is not available to CTH ---Material use:--- CTH: All material use (noted in process tree by STÖ) is accounted for. These alterations in the process tree of the LCA-file give a different amount of limestone use for the production of cement STÖ: Only use of limestone is recognised ---Transports:--- CTH: Final transport from plant differs depending in where the concrete production is situated STÖ: Final transport from Skövde to Göteborg is accounted for (153 km) CTH: Diesel train transports are substituted with electricity without emission factors STÖ: Diesel train is used in some transports CTH: Train transports powered with electricity, uses electricity without emission factors STÖ: Train transports powered with electricity uses Swedish average energy CTH: Substituted with ''Road short-distance'' STÖ: The transport type ''Road transport 5 t'' is not available to CTH CTH: Substituted with ''Road long-distance'' STÖ: The transport type ''Road transport 10 t'' is not available to CTH ---Area:--- CTH: Is not considered STÖ: Is considered ---Noise:--- CTH: Is not considered STÖ: Is considered

Notes	Some supplements to the documentation was done 1999-03-24

SPINE LCI dataset: Clay roof tile manufacturing. ESA-DBP

Administrative	
Finished	Y
Date Completed	1993
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Clay roof tile manufacturing. ESA-DBP
Functional Unit	1 m2 * year
Functional Unit Explanation	1 m2 of clay roof tiles over one year.
Process Type	Cradle to gate
Site	Not applicable
Sector	Consumer goods
Owner	Not applicable
Technical system description	Clay roof tiles for covering of roof. This process is included in the system described in: Blanco-Rosete S. R., 2002, LCA data structure and time series related to construction and maintenance in Sweden. Environmental Systems Analysis report 2002:14, Chalmers University of Technology, Gothenburg, Sweden Other processes in the CPM Database also included in the above publication: Swedish red paint manufacturing and application. ESA-DBP Exterior coating (Swedish red paint) maintenance. ESA-DBP Pine window production. ESA-DBP Floor maintenance. ESA-DBP

System Boundaries	
Nature Boundary	Not applicable.
Time Boundary	1993
Geographical Boundary	Sweden
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data	
General Activity QMetaData	
Date Conceived	1993
Data Type	Unspecified
Represents	See 'Function'.
Method	Unknown.
Literature Reference	Erlandsson M, 1993, Life-Cycle assessment of Building Components. A comparative Life-Cycle assessment of Roof Coverings, Lund University of Technology, Lund, Sweden

Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Heavy fuel oil	1.48			MJ	Technosphere	
	Input	Refined resource	Lime	2.70E-06			kg	Technosphere	
	Input	Refined resource	Oxygen	3.16E-05			kg	Technosphere	
	Input	Refined resource	Sulphuric acid	4.52E-06			kg	Technosphere	
	Input	Resource	Bentonite	2.80E-07			kg	Ground	
	Input	Resource	Biomass	0.000508			kg	Ground	
	Input	Resource	Clay	0.78			kg	Ground	
	Input	Resource	Copper in ore	4.04E-07			kg	Ground	
	Input	Resource	Crude oil	0.000437			kg	Ground	
	Input	Resource	Hard coal	0.000487			kg	Ground	
	Input	Resource	Hydro power	0.0988			MJ	Ground	
	Input	Resource	Iron in ore	1.99E-06			kg	Ground	
	Input	Resource	Lead in ore	7.18E-09			kg	Ground	
	Input	Resource	Lignite	3.88E-06			kg	Ground	
	Input	Resource	Natural gas	4.38E-05			kg	Ground	
	Input	Resource	Uranium in ore	7.50E-07			kg	Ground	
	Input	Resource	Wind power	0.00021			MJ	Ground	
	Output	Emission	Alkanes	8.88E-07			kg	Air	
	Output	Emission	Alkenes	4.44E-08			kg	Air	
Notes: Aromates (C9-C10)	Output	Emission	Aromates	2.22E-07			kg	Air	
	Output	Emission	As	1.92E-08			kg	Air	
	Output	Emission	Benzo(a)pyrene	4.44E-11			kg	Air	
	Output	Emission	Ca	1.18E-07			kg	Air	
	Output	Emission	Cd	4.88E-08			kg	Air	
	Output	Emission	CO	2.29E-5			kg	Air	
	Output	Emission	Co	4.88E-08			kg	Air	
	Output	Emission	CO	8.00E-05			kg	Air	
	Output	Emission	CO2	0.1178			kg	Air	
	Output	Emission	CO2	0.132			kg	Air	
	Output	Emission	COD	7.16E-11			kg	Water	
	Output	Emission	Cr	2.37E-08			kg	Air	
	Output	Emission	Cu	7.25E-08			kg	Air	
	Output	Emission	Dissolved solids	2.86E-07			kg	Water	
	Output	Emission	Dust	6.00E-05			kg	Air	
	Output	Emission	Fe	2.66E-07			kg	Air	
	Output	Emission	Formaldehyde	6.66E-07			kg	Air	
	Output	Emission	HCl	2.13E-06			kg	Air	
	Output	Emission	HF	2.13E-07			kg	Air	
	Output	Emission	Hg	2.22E-10			kg	Air	
	Output	Emission	Hydrocarbons	4.00E-05			kg	Air	
	Output	Emission	Methane	8.04E-06			kg	Air	
	Output	Emission	Mo	2.37E-08			kg	Air	
	Output	Emission	N2O	2-37E-06			kg	Air	
	Output	Emission	Na	1.11E-06			kg	Air	
	Output	Emission	NH3	1.36E11			kg	Water	
	Output	Emission	NH3	3.24E-11			kg	Air	
	Output	Emission	Ni	9.62E-07			kg	Air	
	Output	Emission	NOx	0.000721			kg	Air	
	Output	Emission	N-tot	2.92E-08			kg	Water	
	Output	Emission	Oil	6.84E-10			kg	Water	
	Output	Emission	PAH	7.40E-10			kg	Air	
	Output	Emission	Particles	4.35E-05			kg	Air	
	Output	Emission	Pb	8.44E-08			kg	Air	
	Output	Emission	Propane	4.44E-08			kg	Air	
	Output	Emission	Rn-222	2800			Bq	Air	
	Output	Emission	Se	1.78E-08			kg	Air	

	Output	Emission	SO2	0.001075			kg	Air	
	Output	Emission	Toluene	4.44E-08			kg	Air	
	Output	Emission	V	3.85E-06			kg	Air	
	Output	Emission	VOC	7.84E-07			kg	Air	
	Output	Emission	Zn	5.92E-08			kg	Air	
	Output	Product	Tiles	1			m2 year	Technosphere	
	Output	Residue	Demolition waste	1.89E-06			kg	Technosphere	
	Output	Residue	Highly radioactive waste	1.23E-06			kg	Technosphere	
	Output	Residue	Other	0.002982			kg	Technosphere	
	Output	Residue	Process waste	0.01			kg	Ground	

About Inventory	
Publication	Blanco-Rosete S. R., 2002, LCA data structure and time series related to construction and maintenance in Sweden. Environmental Systems Analysis report 2002:14, Chalmers University of Technology, Gothenburg, Sweden
Intended User	LCA practitioners.
General Purpose	This process data set is recalculated to fit in the Master Thesis given in 'Publication'. Excerpt from the report (see 'Publication'): ''Construction, building maintenance and housing management contribute to a large extent to the environmental impact. When housing owners and managers perform their activities they should be aware of the environmental effects they cause. The environmental impact of existing houses could be addressed and diminished within the possibilities of a clever management.''
Detailed Purpose	Excerpt from the report (see 'Publication'): ''This master thesis descibes and defines a building system model for a multi-family house in Gothenburg over a 30 year period from 1970 to 2002 . The model was used to collect environmental impact information regarding materials or products used in the construction and maintenance of a building . The environmental impact ofa a multi-family house was evaluated through a Life Cycle Assessment (LCA). Finally to account the long sevice lifetime of a multi-family house two case studies were carried out to test if the use of Time series can illustrate the environmental impact of maintenance activities caused by decisionmaking in housing management.''
Commissioner	Not applicable - .
Practitioner	Sergio R. Blanco-Rosete - .
Reviewer	Birgit Brunklaus - Environmental Systems Analysis
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpt from the report (see 'Publication'): ''The study is based on the functional unit equal to one square meter roofing during its useful life (65 years). The functional unit does not include the substructure. When the calculations for the LCI were performed the original data was modified to fit according to the functional unit of this study.'' ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-09-21 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Cleaning and blastering of cast iron

Administrative	
Finished	Y

Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Cleaning and blastering of cast iron
Functional Unit	33,75 kg cleaned and blastered cast iron
Functional Unit Explanation	33,75 kg cast iron is needed to produce one guide ring (9,604 kg)
Process Type	Unit operation
Site	SKF Mekan ABBox 89 641 21 Katrineholm
Sector	Materials and components
Owner	SKF Mekan ABBox 89 641 21 Katrineholm
Technical system description	This activity describes a process step included in the whole system activity ''Production of guide rings used for spherical roller bearings'', also available in the SPINE@CPM database. The guide ring is manufactured at SKF Mekan AB in Katrineholm and the process consists of several steps. See the activity ''Production of guide rings used for spherical roller bearings'' for details. The guide ring will finally be mounted into the SKF Spherical Roller Bearing 232/530. The function of the guide ring is to assure that the rollers stay in the raceways of the bearing. The guide ring is made of cast iron, produced mainly from scrap. After smelting of the raw materal the smelt iron is casted in a sand form. The cast iron is then further processed into guide rings. This dataset describes the cleaning and blastering of the cast iron after the casting process. ------------------ Cleaning and blastering of cast iron : When the cast iron have been cooled it is cleaned and blastered. It means that remaining material from the casting process (e.g. sand) is removed. This process is identical for bearing housing and guide rings. The casted iron components are cleaned and blastered to get rid of remaining sand and to treat the surface. This process is identical for bearing housing and guide rings produced at SKF Mekan AB in Katrineholm, and the data is obtained from an earlier LCA study: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.

System Boundaries	
Nature Boundary	Emissions to air and water are included. See details in the report from where the data is taken: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Time Boundary	The data was collected during autumn 2002 and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The cleaning and blastering process takes place at SKF Mekan AB in Katrineholm, Sweden
Other Boundaries	The production of electricity and district heat are NOT included in this dataset and must be followed from the cradle in order to obtain the total environmental impact. See details in the report from where the data is taken: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Allocations	Allocations have been made according to weight.
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed

Represents	See 'Function'.
Method	This data set is obtained from an earlier LCA study from SKF Mekan AB of Bearing Housing. All data could according to Marja Andersson at SKF Mekan AB in Katrineholm also be used for the guide ring, since the processes are the same. The data was recalculated to our specific weight (33,75 kg), since the allocations were made according to weight.
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Cast iron	33.75			kg	Technosphere	
	Input	Refined resource	District heat	7275292			J	Technosphere	
	Input	Refined resource	Electricity	865418			J	Technosphere	
	Input	Refined resource	Steel	0.10834			kg	Technosphere	
	Output	Emission	Cd	3.13e-008			kg	Air	
	Output	Emission	Cr	3.73e-006			kg	Air	
	Output	Emission	Cu	7.81e-006			kg	Air	
	Output	Emission	Ni	9.45e-007			kg	Air	
	Output	Emission	Particles	0.00179			kg	Air	
	Output	Emission	Pb	8.79e-006			kg	Air	
	Output	Emission	Zn	7.09e-006			kg	Air	
	Output	Product	Cast iron	33.75			kg	Technosphere	
	Output	Residue	Particles	2.141			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for cleaning and blastering of cast iron at the specific site at SKF Mekan AB in Katrineholm, Sweden.
About Data	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	

SPINE LCI dataset: Cleaning of bearing roller

Administrative

Finished	Y
Date Completed	2002-12-12

Copyright	
Availability	

Technical System	
Name	Cleaning of bearing roller
Functional Unit	55.2 kg rollers
Functional Unit Explanation	The rollers are made of steel and weigh 9.2 kg each. There are 36 rollers in the SRB size 232/530 (see SKF General Catalogue for more info) that this dataset treats.
Process Type	Unit operation
Site	Halmstad
Sector	
Owner	Halmstad
Technical system description	This activity is a process step that is included in the process Coating of bearing rollers. The cleaning proceeds the surface coating, and both of them takes place at Balzers Sandvik Coating AB. The rollers are put in metal baskets large enough to take two SKF rollers RS-232/530 C, i e rollers for a bearing size 232/530. The cleaning process is divided into 9 steps, and the baskets are lowered in nine different baths. In the first step they are washed thoroughly to take away oil scrap from the manufacturing of rollers. Step 2 is an ultrasonic bath also containing a water-based cleaning solution. After the ultrasonic bath is a rinse bath. Step 2 and 3 is repeated three times, with softer cleaning agents for each new step. The two final steps are another two rinse baths. The wastewater from the first two steps is sent to destruction at SAKAB because it can contain oil scrap that derives from the manufacturing of the components. The wastewater from the last six steps is let out to the municipal sewage. The system starts with the inflow of freshwater, cleaning agents, energy and rollers, and it ends with the outflow of wastewater and clean rollers. For further reading about Coating of bearing rollers read Environmental Report from year 2001 Balzers Sandvik Coatings AB and Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002.

System Boundaries	
Nature Boundary	The process has an inflow of fresh water that is a natural resource. All the other inflows come from the technosphere. All outflows leaves for the technosphere.
Time Boundary	The report from which the data is taken is published year 2001. No changes planned for the nearest future.
Geographical Boundary	This cleaning process takes place in Halmstad, Sweden.
Other Boundaries	The operation is proceeded in water and all flows are liquid flows except for the rollers. Production of electricity is not included in this dataset.
Allocations	The total amount of chemicals used during a year is divided to give an equal amount for each cleaning batch. This amount is then divided in 2 since there is room for two rollers size 232/530 in each cleaning basket. This gives the amount of used energy and chemicals for the cleaning of one roller.
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	2002-09-12 - 2002-12-31
Data Type	Economical information
Represents	N/A
Method	All data have been measured by the company (Balzers) and are reported in their environmental report for year 2001. The calculations are based on economical value, purchased amount of cleaning agents.
Literature Reference	Environmental Report 2001 - Balzers Sandvik Coating AB.
Notes	There is information about the chemicals in the specific QMetaData.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Municipal water.	Input	Natural resource	Water	10.02			l	Water	Sweden
Notes: Cleaning agent provided by Borer Chemie.	Input	Refine resource	Deconex HT1153	15.198			g	Technosphere	Sweden
Notes: Cleaning agent provided by Borer Chemie.	Input	Refine resource	Deconex HT115D	18.234			g	Technosphere	Sweden
Notes: Cleaning agent provided by Borer Chemie.	Input	Refine resource	Deconex HT1169	22.794			g	Technosphere	Sweden
Notes: Cleaning agent provided by Borer Chemie.	Input	Refine resource	Deconex HT1175	38.904			g	Technosphere	Sweden
Notes: Cleaning agent provided by Borer Chemie.	Input	Refine resource	Deconex HT1217	11.4			g	Technosphere	Sweden
Notes: Cleaning agent provided by Borer Chemie.	Input	Refine resource	Deconex SP33	59.268			g	Technosphere	Sweden
Notes: Corrosion protective agent provided by Tamro.	Input	Refine resource	Dimethylethanolamine	4.5594			g	Technosphere	Sweden
Notes: The electricity is used to heat the water and to run the automatic process.	Input	Refine resource	Electricity	0.9378			kWh	Technosphere	Sweden
Notes: The ethanol is provided by Kemetyl.	Input	Refine resource	Ethanol	1416			MJ	Technosphere	Sweden
Notes: The hydrogen peroxide is provided by Brenntag.	Input	Refine resource	Hydrogen peroxide	1306.8			g	Technosphere	Sweden
Notes: For further information see Functional unit explanation.	Input	Refine resource	roller	55.2			kg	Technosphere	Sweden
Notes: The sodium carbonate is provided by Tamro.	Input	Refine resource	Sodium carbonate	0.912			g	Technosphere	Sweden
Notes: The sodium hydroxide is provided by Brenntag.	Input	Refine resource	Sodium hydroxide	59.04			g	Technosphere	Europe
Notes: For further information see Functional unit explanation.	Output	Product	roller	55.2			kg	Technosphere	Sweden
Notes: The wastewater is partly sent for destruction at the sewage treatment plant in Halmstad, partly let out with the municipal sewage.	Output	Residue	Industrial	10.002			l	Technosphere	Sweden

About Inventory

Publication	Environmental Report from year 2001 Balzers Sandvik Coatings AB. Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002. ------------- Data documented by Sandra Häggström, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-03-21.
Intended User	Product developer at SKF and B
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The purpose for our study is to compare a coated roller bearing to a non-coated, from cradle to grave. The coating of the rollers is preceded by a cleaning treatment.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	The dataset describes a cleaning process that is conducted in order to make substrates clean before they are coated in a PVD process. Care has to be taken to substrate size because the same amount of chemicals is used for one bath, and how many items there is room for in one bath depends on substrate size. The dataset is compiled for rollers RS-232/530 C in SKF roller bearings size 232/530 (see SKF General Catalogue for more info).
About Data	All data are gathered from a specific site, the Balzers Sandvik Coatings AB in Halmstad, Sweden. The data have been measured by the company (Balzers) and is reported in their environmental report for year 2001. The calculations are based on economical value, purchased amount of cleaning agents.

Notes	

SPINE LCI dataset: Cleansing of glass containers

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System	
Name	Cleansing of glass containers
Functional Unit	1 kg
Functional Unit Explanation	1 kg cleansed glass containers.
Process Type	Gate to gate
Site	Sweden
Sector	
Owner	Sweden
Technical system description	Cleansing of glass containers.

System Boundaries	
Nature Boundary	No such parameters are measured in this study. No emissions from the combustion (production) of fossil fuels are included.
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are electricity and fossil fuel consumption Glass containers come from, and cleansed glass containers go to, the technosphere. No transports are included.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1991-01-01
Data Type	Estimated from similarity
Represents	N/A
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.

Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	There is information about the chemicals in the specific QMetaData.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: The amount 0,005913 kWh/l is recalculated to 0,0230 MJ/kg in the reference literature. One bottle is 33-cl, that is 305 g.	Input	Refined resource	Electricity	0.0230			MJ	Technosphere	
Method: The amount 0,1069 kWh/l is recalculated to 0,416 MJ/kg in the reference literature. One bottle is 33-cl, that is 305 g.	Input	Refined resource	Fossil fuel	0.416			MJ	Technosphere	
	Input	Refined resource	Glass container	1			kg	Technosphere	
Notes: Pure soda is diluted to a 50% dissolvment.	Input	Refined resource	Washing soda	0.007			l	Technosphere	
	Output	Product	Glass container	1			kg	Technosphere	

About Inventory

Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and use of glass.
Detailed Purpose	To show the energy consumption for cleansing of glass containers.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	
About Data	The weight of one glass container can be approximated with the weight of one 33-cl glass bottle, that is 305 g.
Notes	

SPINE LCI dataset: Cleansing of juice bottles

Administrative

Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System

Name	Cleansing of juice bottles
Functional Unit	1 kg
Functional Unit Explanation	1 kg cleansed juice bottles.
Process Type	Gate to gate
Site	Sweden
Sector	
Owner	Sweden
Technical system description	Cleansing of juice bottles.

System Boundaries

Nature Boundary	No such parameters are measured in this study. No emissions from the combustion (production) of electricity and fossil fuel is included.
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are electricity and fossil fuel consumption Juice bottles come from, and cleansed juice bottles go to, the technosphere. No transports are included.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991-01-01
Data Type	Estimated from similarity
Represents	N/A
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	There is information about the chemicals in the specific QMetaData.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: The amount 0,005952 kWh/l beverage is recalculated to 0,0367 MJ/kg glass in the reference literature.	Input	Refined resource	Electricity	0.0367			MJ	Technosphere	
Method: The amount 0,0995 kWh/l beverage is recalculated to 0,597 MJ/kg glass in the reference literature.	Input	Refined resource	Fossil fuel	0.597			MJ	Technosphere	
Notes: The weight of one 1 l juice bottle is 600 g.	Input	Refined resource	Juice bottles	1			kg	Technosphere	
Notes: The weight of one 1 l juice bottle is 600 g.	Output	Product	Juice bottles	1			kg	Technosphere	

About Inventory

Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and use of glass.
Detailed Purpose	To show the energy consumption for cleansing of juice bottles.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	
About Data	The weight of one 1 l juice bottle is 600 g.
Notes	

SPINE LCI dataset: Clearing of young forest

Administrative	
Finished	Y
Date Completed	1998-02-13
Copyright	None
Availability	Public

Technical System	
Name	Clearing of young forest
Functional Unit	ha
Functional Unit Explanation	Per hectare cleared young forest land.
Process Type	Gate to gate
Site	Sweden
Sector	Forestry
Owner	Sweden
Technical system description	When the forest plants have grown to a height of about 2 m, a clearing is often made in order to limit the competition and help the best plants, using a portable clearing saw.

System Boundaries	
Nature Boundary	Emissions caused by combustion of fuels are not included in the study.
Time Boundary	Technical development may decrease the fuel demand.
Geographical Boundary	Sweden
Other Boundaries	Transport of personell and facilities are not included.

Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	94-02-24
Data Type	Unspecified, expert outspoke
Represents	N/A
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	U. Hallonborg, Skogforsk.
Notes	There is information about the chemicals in the specific QMetaData.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: For clearing a portable clearing saw is used. 0,03 l gasoline per m3sub is used, which is 0,94 MJ. This corresponds to 377 MJ per ha (assuming 400 m3/ha and 31,4 MJ/l gasoline). U. Hallonborg, Skogforsk	Input	Refined resource	Gasoline	377			MJ	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Derived from Planting softwood plants	Input	Refined resource	Planted forest area	1			ha	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke	Output	Product	Young forest area	1			ha	Technosphere	Sweden

About Inventory

Publication	None -- Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose is to supply with LCA-data for forestry to be used in further studies of wood products.
Detailed Purpose	These data are an update of earlier data on the same subject. Can also be used as an average for Sweden.
Commissioner	- Stora Corporate Research, Box 601 661 29 Säffle Sweden.
Practitioner	Swan, Göran - Stora Corporate Research, Box 601, S-661 29 Säffle, Sweden.
Reviewer	
Applicability	These data are valid for large scale clearing in forestry. It is important to check the type of fuel used. In this case, fossil fuel is assumed to be used. Other data is available from other forest companies, or from Skogforsk, or STFI. The silviculture process in Sweden has eight steps: 1. Plant nursing 2. Soil preparation 3. Planting 4. Clearing 5. Thinning 6. Fertilizing 7. Final felling 8. Forwarding This is the fourth step.

About Data	N/A
Notes	N/A

SPINE LCI dataset: CNG combustion in heavy duty truck or bus, spark ignition engine, Euro V, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	CNG combustion in heavy duty truck or bus, spark ignition engine, Euro V, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of CNG to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from compressed natural gas (CNG) combustion in heavy duty truck or bus with a spark ignition (SI) engine, Euro V, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data	
General Activity QMetaData	
Date Conceived	

Data Type	
Represents	N/A
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on ETC (transient test cycle for truck and bus engines), legislation limits for Euro V (2005/55/EC). The ETC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.40 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of N2O was best estimate.
Literature Reference	Main references: (1) 2005/55/EC (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) Svensk fordonsgasstandard 155438 (5) The values are published by Swedegas; http://www.swedegas.se/gasnatet/gaskvalitet/gaskvalitet_i_sverige. Here an Excel file (containing measured heat values and densitites per each month) can be downloaded.
Notes	There is information about the chemicals in the specific QMetaData.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Product	Compressed natural gas (CNG)	1			MJ	Technosphere	
Method: The emission factor applied (0.0573 kg CO2/MJ natural gas) was found in Jerksjö et al. (2010) refered to in Miljöfaktaboken 2011, Uppskattade emissionsfaktorer för bränslen, el,värme och transporter. Jerksjö, Martin. Martinsson, Fredrik (2010). Hämtning och bearbetning av data från modellen HBEFA3.1EV – The Handbook of Emission Factors for Road Transport (www.hbefa.net). The emission factor agrees well with other data sources such as PE International Gabi database. Literature:	Output	Emission	Carbon dioxide (fossil)	0.0573			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Carbon monoxide	4.44444444444444E-04			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Methane	1.22222222222222E-04			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Nitrogen oxides	2.22222222222222E-04			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment	Output	Emission	Nitrous oxide	5.55555555555556E-06			kg	Air	

systems.									
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Non-methane volatile organic compounds	6.11111111111111E-05			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Particles (unspecified)	3.33333333333333E-06			kg	Air	
Method: A conservative value since the legislation for vehicle gas based on biogas has a limit of 20 ppm sulphur in Sweden (SS 15 54 38) . 1 kg sulphur causes 2 kg SO2. There is no standard for CNG. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 47.88 MJ/kg (Swedegas). Literature: A conservative value	Output	Emission	Sulfur dioxide	8.35421888053467E-07			kg	Air	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: CNG combustion in heavy duty truck or bus, spark ignition engine, Euro VI, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System

Name	CNG combustion in heavy duty truck or bus, spark ignition engine, Euro VI, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of CNG to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from compressed natural gas (CNG) combustion in heavy duty truck or bus with a spark ignition (SI) engine, Euro V, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	N/A
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on WHTC (World Harmonized Transient Cycle for truck and bus engines), legislation limits for Euro VI (Commission Regulation (EC) No 582/2011).The WHTC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.40 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of N2O was best estimate.
Literature Reference	Main references: (1) Commission Regulation (EC) No 582/2011 (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) SS 15 54 38 (5) The values are published by Swedegas; http://www.swedegas.se /gasnatet/gaskvalitet/gaskvalitet_i_sverige. Here an Excel file (containing measured heat values and densitites per each month) can be downloaded.
Notes	There is information about the chemicals in the specific QMetaData.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Product	Compressed natural gas (CNG)	1			MJ	Technosphere	

Method: The emission factor applied (0.0573 kg CO2/MJ natural gas) was found in Jerksjö et al. (2010) refered to in Miljöfaktaboken 2011, Uppskattade emissionsfaktorer för bränslen, el,värme och transporter. Jerksjö, Martin. Martinsson, Fredrik (2010). Hämtning och bearbetning av data från modellen HBEFA3.1EV – The Handbook of Emission Factors for Road Transport (www.hbefa.net). The emission factor agrees well with other data sources such as PE International Gabi database. Literature:	Output	Emission	Carbon dioxide (fossil)	0.0573			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Carbon monoxide	0.000444			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Methane	0.0000556			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Nitrogen oxides	0.0000511			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	0.00000556			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Non-methane volatile organic compounds	0.0000178			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Particles (unspecified)	0.00000111			kg	Air	
Method: A conservative value since the legislation for vehicle gas based on biogas has a limit of 20 ppm sulphur in Sweden (SS 15 54 38) . 1 kg sulphur causes 2 kg SO2. There is no standard for CNG. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 47.88 MJ/kg (Swedegas). Literature: A conservative value	Output	Emission	Sulfur dioxide	0.000000835			kg	Air	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	

	About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
	Notes	

SPINE LCI dataset: Coal fired plant for heat and power production - Large plant

Administrative	
Finished	Y
Date Completed	2000-07-07
Copyright	
Availability	Public

Technical System	
Name	Coal fired plant for heat and power production - Large plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a coal fired plant for heat and power production. The plant is located in Sweden and is fired with black coal. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport used in association with the fuel chain and the operation and maintenance of the plant are not included. The data reported here is from 1985. There is difficulties in getting new data from combustion of coal, because it has become less profitable to use coal as fuel due to higher taxes for the energy produced. Several coal fired heat and power plants have been converted for the use of biomass fuels instead, due to lower taxes for the energy production with these fuels. The data though are typical for an older coal fired plant for heat and power production. TECHNICAL DATA FOR THE STUDIED PLANT: The data is taken from a performance test. The lenght of the performance test (hours) : 4 Total electric and thermal output (MW): 90 Total fuel use (MWh) : 323 Production of heat and electricity (MWh) : 283 Degree of thermal effieciency (%) : 87,6 PROCESS DESCRIPTION: The plant consists of a steam boiler unit of 90 MW thermal output. The dust is removed from the flue gas in an electrostatic precipitator. INCLUDED OPERATIONS: The process of the study consists of the following operations: - The feeding of the coal into the combustion process. - The combustion process. - The internal treatment of residues from the combustion process. - The removal of dust from the flue gas in the electrostatic precipitator. - The internal consumption of electricity. NOx CONTROL: No NOx control system is used in the plant. OTHER FLUE GAS CLEANING SYSTEMS: For the removal of dust from the flue gas an electrostatic precipitator is used. No sulphur control is needed, due to the low sulphur content in the fuel, 0,54 %. - In an electrostatic precipitator the dust particles are electrified and then separated from the flue gas stream by passing through an electric field with largest possible intensity.

System Boundaries	
Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: The data for reported in- and outflows are taken from the final inspection of the plant. The emission of HC is not measured.

Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data mainly from 1985. The data consists of avarage data during four hours of performance test. This data is valid for an older coal fired plant for heat and power production.
Geographical Boundary	GEOGRAPHICAL EXTENSION (for large technical systems): This inventory has beeen conducted on a coal fired plant for heat and power production in Sweden, with swedish regulations, applicable during 1985. The collected data should only be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the internal electricity consumption. - The water consumption in the process. - The chemicals used for feedwater treatment. - The production of the stone coal. - The transportation of the fuel to the plant. - The transportation of the residues from the combusiton and cleaning process to the landfill. - The process at the landfill such as leaching, decomposition etc.
Allocations	PRINCIPLE APPLIED: In a combined power and heating plant two products of economic value are produced. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat and power respectively. For the use of resources and the emissions that are specific for the power production are allocated to that production. Equivalent to this the use of resources and the emissions specific for the heat production are allocated to that production. Note: When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985
Data Type	
Represents	
Method	All data reported are related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total amount
Literature Reference	The data are recieved from ''Prestandaprov med de av Götaverken Energy Systems AB för fastbrämsleeldning konverterade oljeeldade ångpannorna P1 och P2, Borås Energi AB, 1985''.
Notes	The parameters presented are chosen because they are available in the performans test report of the plant. Data can be missing if it is not reported in the report. The type of data reported in the environmental report is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate. For some flows specific information is given, see each flow.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: Not known.	Input	Refined resource	Electricity	0.0438			kWh	Technosphere	
Method: From the consumed amount during the performance test. Literature: Prestandaprov med de av Götaverken Energy Systems AB för fastbrämsleeldning konverterade oljeeldade ångpannorna P1 och P2, Borås Energi AB, 1985	Input	Refined resource	Stone coal	166			g	Technosphere	
Data type: Monitored data, continuous Method: This emission is measured continously during the perforamce test. Literature: Prestandaprov med de av Götaverken Energy Systems AB för fastbrämsleeldning konverterade oljeeldade ångpannorna P1 och P2, Borås Energi AB, 1985	Output	Emission	CO	0.0730			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continously during the performance test. Literature: Prestandaprov med de av	Output	Emission	CO2	344			g	Air	

Götaverken Energy Systems AB för fastbrämsleeldning konverterade oljeeldade ångpannorna P1 och P2, Borås Energi AB, 1985									
Data type: Single sample Method: The emission of dust was estimated from a single sample taken during the test period. Literature: Prestandaprov med de av Götaverken Energy Systems AB för fastbrämsleeldning konverterade oljeeldade ångpannorna P1 och P2, Borås Energi AB, 1985	Output	Emission	Dust	0.00142			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continously during the performance test. Literature: Prestandaprov med de av Götaverken Energy Systems AB för fastbrämsleeldning konverterade oljeeldade ångpannorna P1 och P2, Borås Energi AB, 1985	Output	Emission	NOx	0.965			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continously during the performance test. Literature: Prestandaprov med de av Götaverken Energy Systems AB för fastbrämsleeldning konverterade oljeeldade ångpannorna P1 och P2, Borås Energi AB, 1985	Output	Emission	SO2	1.48			g	Air	
Method: Not known. Literature: Prestandaprov med de av Götaverken Energy Systems AB för fastbrämsleeldning konverterade oljeeldade ångpannorna P1 och P2, Borås Energi AB, 1985	Output	Product	Heat	1			kWh	Technosphere	
Method: From the formed amount during the performance test. Literature: Prestandaprov med de av Götaverken Energy Systems AB för fastbrämsleeldning konverterade oljeeldade ångpannorna P1 och P2, Borås Energi AB, 1985	Output	Residue	Bottom ash	18.5			g	Technosphere	
Method: From the formed amount during the performance test. Literature: Prestandaprov med de av Götaverken Energy Systems AB för fastbrämsleeldning konverterade oljeeldade ångpannorna P1 och P2, Borås Energi AB, 1985	Output	Residue	Fly ash	13			g	Technosphere	

About Inventory

Publication	Data documented by: Maria Münter, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1985. The data consists of average data from a performance test. This data is assumed to be valid for an older coal fired heat and power plant. There is difficulties in getting new data from combustion of coal, because it has become less profitable to use coal as fuel due to higher taxes for the energy produced from coal. Several coal fired heat and power plants have been converted for the use of biomass fuels instead, due to lower taxes for the energy production with these fuels. The data though are typical for an older coal fired plant for heat and power production. When both heat and power are produced the allocation between the products are the same.

	That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
About Data	Data quality in the meaning good precision for the operation of the plant concerning for example precision of emission measurements, calibration of instruments are good since the measurements have been performed by an athorized measurement firm.
Notes	Combined heat and power plants are used as base primarly during the winter half, when the need for heat and power are the largest.

SPINE LCI dataset: Coal mining and cleaning. ESA-DBP

Administrative	
Finished	Y
Date Completed	1996
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Coal mining and cleaning. ESA-DBP
Functional Unit	1 kg of coal
Functional Unit Explanation	
Process Type	Gate to gate
Site	Unknown
Sector	Mining and quarrying
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''Coal mining is done either underground or at the surface. Underground mining is the most common in UK. After mining the coal is treated by crushing, screening and washing before it can be used.'' This process is included in the system described in: Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Cast iron production. ESA-DBP - Limestone quarrying. ESA-DBP - Sand extraction and processing. ESA-DBP - Sinter plant's process ESA-DBP - Uranium ore extraction and enrichment. ESA-DBP - Production of pig iron - blast furnace process. ESA-DBP

System Boundaries	
Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) emissions to air, emissions to water, and waste generation.
Time Boundary	1994
Geographical Boundary	United Kindom
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other report.
Literature Reference	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Data for particular process come from: Landbank Environmental Research & Consulting (1994), The Phosphate Report, Landbank
Notes	The parameters presented are chosen because they are available in the performans test report of the plant. Data can be missing if it is not reported in the report. The type of data reported in the environmental report is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate. For some flows specific information is given, see each flow.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Raw coal	1.88E+00			kg	Ground	United Kingdom
	Input	Refined resource	Electricity	1.00E-01			MJ	Technosphere	United Kingdom
	Input	Resource	Process air	4.51E+00			kg	Air	United Kingdom
Notes: NB: no information whether the water used is fresh or reused	Input	Resource	Process water	2.84E+00			kg	Water	United Kingdom
	Output	Emission	Aluminium	1.40E-04			kg	Water	United Kingdom
	Output	Emission	CH4	1.00E-02			kg	Air	United Kingdom
	Output	Emission	Chlorides	3.30E-04			kg	Water	United Kingdom
	Output	Emission	CO	7.00E-05			kg	Air	United Kingdom
	Output	Emission	Dissolved solids	9.00E-04			kg	Water	United Kingdom
	Output	Emission	Iron	1.12E-03			kg	Water	United Kingdom
	Output	Emission	Manganese	2.00E-05			kg	Water	United Kingdom
	Output	Emission	NH4	4.00E-05			kg	Water	United Kingdom
	Output	Emission	NOx	1.30E-04			kg	Air	United Kingdom
	Output	Emission	Particulates	5.00E-05			kg	Air	United Kingdom
	Output	Emission	SO2	1.00E-05			kg	Air	United Kingdom
	Output	Emission	Sulphates	8.00E-03			kg	Water	United Kingdom
	Output	Emission	Suspended solids	7.40E-04			kg	Water	United Kingdom
	Output	Emission	Waste air	4.62E+00			kg	Air	United Kingdom
	Output	Emission	Waste water	2.84E+00			kg	Water	United Kingdom
	Output	Emission	VOC	2.00E-05			kg	Air	United Kingdom
	Output	Product	Coal	1.00E+00			kg	Technosphere	United Kingdom
	Output	Residue	Solid waste	7.40E-01			kg	Technosphere	United Kingdom

About Inventory

Publication	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden.

Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The aim of the study is to undertake an LCA of typical water and sewage pumps. Those aspects which have a major contribution to the environmental impact in the life cycle of a pump will be identified.''
Detailed Purpose	Coal is used to produce energy for production and use phase of water pump.
Commissioner	Unknown - .
Practitioner	Johanna Thuresson - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Coarse mortar production

Administrative	
Finished	Y
Date Completed	1996-10-01
Copyright	
Availability	Public

Technical System	
Name	Coarse mortar production
Functional Unit	kg
Functional Unit Explanation	1 kg coarse mortar
Process Type	Gate to gate
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	This system includes the production of cement, dolomite, limestone and sand. Cement, dolomite, limestone, cellulose derivative, pigments and sand is mixed at Ernström Bygg AB (Björkaverken, 710 23 Glanshammar, Sweden +46 -19 463300), the plant for mortar production. It is packaged in paper bags, 25 kilo for each mortar package or reusable 'big-packs'. Coarse mortar consist of: Binder: Lime and cement. Aggregates: Dolomite and sand. Admixtures: air entering agent and plastizicer. Portland cement Portland cement is bought from Cementa in Skövde. It is delivered in bulk, 10 tons each

time to the mortar plant in Glanshammar.

Mineral (Dolomite)
Ernströms have their own open pit mine where the dolomite is mined. The dolomite is crushed into aggregates.

Limestone (Calcium hydroxide)
Calcium hydroxide is bought from Svenska mineral in Rättvik, and is transported with heavy truck to Glanshammar (the transport is not considered in this set of data). Burnt lime is the raw material for production of calcium hydroxide. Water is added to the lime, heat is released and calcium hydroxide becomes the final product. It is represented as Limestone.

Additives (Cellulose derivative)
No data has been collected for cellulose derivative because of its small weight share compared to the total mass. The derivative is produced from betyle cellulose. No transport distance is accounted for.

Chemicals (Pigments)
No data has been collected for pigments (but use of pigment is accounted for as a non-elementary flow).

Aggregates (Sand)
The mortar plant is self providing with sand.

Admixtures
No data for the amount of used admixtures has been at hand, consequently the use is not taken into account.

Waste
Waste handling has not been accounted for, but the waste generated is deposited in the open pit mine.

System Boundaries

Nature Boundary	Waste No waste values for waste generations have been available, but the waste generated is deposited in the open pit mine.
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996-01-01
Data Type	Unspecified
Represents	See 'Function'
Method	Personal communication
Literature Reference	Personal communication: Vassals Hadziantonio at Ernström Bygg AB.
Notes	The data type unspecified implies that one do not know what the data is based on.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Aggregates consist of sand.	Input	Natural resource	Aggregates	250			g	Other	
	Input	Natural resource	Cement	80			g	Other	
	Input	Natural resource	Dolomite	580			g	Other	
	Input	Natural resource	Limestone	189			g	Other	
Notes: Additives consist of cellulose derivative.	Input	Refined resource	Additives	10			g	Technosphere	
	Input	Refined resource	Electricity	0.158			MJ	Technosphere	

Notes: The density of coarse mortar is 1500 kg/m3.	Output	Product	Coarse mortar	1			kg	Technosphere	

About Inventory	
Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden -- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology --
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural wooden and concrete frames in buildings during the whole life cycle, by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of coarse mortar
Commissioner	- Finncement Finland .
Practitioner	Björklund Thomas, Tillman Anne-Marie - Technical Environmental Planning, CTH 412 96 Göteborg Sweden.
Reviewer	
Applicability	To calculate the total environmental load, including the cement production, you can use the data in this Database at: Name: Cement production Category: Cradle to gate Publication: LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund T., Tillman A-M.; Report 1997:2; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden
About Data	Dolomite The mine is close by the mortar plant so the transport distance is negligible. Energy use due to extraction of dolomite is integrated in the energy value. Limestone (Calcium hydroxide) No energy use due to production of calcium hydroxide is accounted for. Additives (cellulose derivative) No data has been collected for cellulose derivatives because of its small weight share compared to the total mass. Cellulose derivative is accounted for as a non-elementary flow. Chemicals (Pigments) No data is collected for pigments but use of pigment is accounted for as a non-elementary flow. Energy use Energy data for the plant in Glanshammar is given as a total for the entire plant. 45 000 tons of mortar is produced annually. Energy use amounts to 1.5 GWh of electricity annually, thus 120 MJ/ton mortar is the energy use. Electricity is accounted for as a non-elementary flow. No other products are made at the plant. The density of coarse mortar is 1500 kg/m3. Transports The cement is transported 170 km by heavy truck from Cementa to the mortar plant in Glanshammar. The limestone is transported a distance of 260 km by heavy truck, from Svenska mineral in Rättvik to Glanshammar. Further, the transport distance to the main storage is 20 km and it is done by truck. These transports are not considered in this set of data.
Notes	

SPINE LCI dataset: Coastal shipping

Administrative

Finished	Y
Date Completed	1994-04-01
Copyright	
Availability	Public

Technical System

Name	Coastal shipping
Functional Unit	tonkm
Functional Unit Explanation	The energy use and exhaust emissions are calculated with reference to the transportation of 1 ton goods, 1 kilometre.
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation of a ship used in coastal shipping.

System Boundaries

Nature Boundary	Emissions to air from combustion of the fuel are included. Other environmental impacts from the operation of the ship are not included.
Time Boundary	The aim was that the figures would represent the fleet in 1992
Geographical Boundary	Sweden and other countries with a similar fleet.
Other Boundaries	Utilisation level is not known. *Not included in the system:* Production and distribution of the fuel Manufacture and maintenance of the ship
Allocations	PRINCIPLE APPLIED: DESCRIPTION:
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study)

Flow Data

General Activity QMetaData

Date Conceived	1990-1994
Data Type	Unspecified
Represents	See 'Function'
Method	Data compiled from different literature sources. The emissions were calculated from emission factors; the emission factor for each specific substance was multiplied with the energy use for the given transport. The emission factors were: SO2 1,28 g/MJ NOx 2,5 g/MJ CO 0,22 g/MJ CO2 72 g/MJ HC 0,06 g/MJ Particles 0,11 g/MJ For details on how the emission factors were obtained, see metadata for each specific substance. Metadata for CO and HC can be found under CO. Metadata for SO2 and particles can be found under SO2.
Literature Reference	Tillman, A-M. `Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995
Notes	-

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes:	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1990 Data type: Derived, unspecified Method: The energy use were calculated for a *specific ship* in Habersatter. Data for the ship were: Net load 3000 tonnes Specific engine capacity 0.5 kW/ ton netto Specific fuel use 0,224 kg/kWh Average	Input	Refined resource	Heavy oil	0.47			MJ	Technosphere	

speed 10 km/h This gives a fuel use of 0,0112 kg/tonkm or 0,47 MJ/tonkm (heat value for diesel 42,5 MJ/kg). The data were supplied by a shipping company Literature: Habersatter, K. \`Oekobilanz von Packstoffen - Stand 1990\`. Schriftenreihe Umwelt nr 132, Bundesamt fur Umwelt, Walt und Landschaft (BUWAL), Bern 1991. Notes: *Reviewers comment:* The energy use for different types of ships can vary depending on e. g. size, shape of the hull, hydrodynamic properties and engine strength. This can give a very broad distribution in the energy use depending on which individual ships the energy use were based.									
Notes:	Output	Cargo	Cargo	1.000000			tonne	Technosphere	
Date concieved: 1992 Data type: Unspecified Method: Lenner has calculated *average emission factors* in g/tonkm, intended to represent an average value for all shipping in Sweden. They are therefore calculated for a combination of several types of ships. Emission factors in g/MJ were obtained by division of the emission factors in g/tonkm by the average energy use (0,051 g/MJ). Lenner has not stated how the values were retrieved. Literature: Lenner, M. \`Energiförbrukning och avgasemission för olika transporttyper\` VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 Notes:	Output	Emission	CO	0.1			g	Air	
Date concieved: 1992 Data type: Unspecified Method: The emission factor was calculated from the fuel use (0,18 g/MJ) using the carbon content in diesel. The data used in the calculation was: Heat value: 42,82 MJ/kg Density: 0,83 kg/dm3 CO2 emission: 2,61 kg CO2/dm3 fuel Literature: Lenner, M. \`Energiförbrukning och avgasemission för olika transporttyper\` VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 Notes:	Output	Emission	CO2	34			g	Air	
Notes:	Output	Emission	HC	0.028			g	Air	
Date concieved: 1992 Data type: Unspecified Method: Lenner has calculated an *average emission factor* in g/tonkm, intended to represent an average value for all shipping in Sweden. They are therefore calculated for a combination of several types of ships. Emission factors in g/MJ were obtained by division of the emission factors in g/tonkm by the average energy use (0,051 g/MJ). The data was based on figures found in a document written by the Swedish Environmental Agency (Planeringsunderlag..). The emission factors in this document are given for four-stroke engines, and based on an investigation of exhaust emissions from shipping in Sweden made by Alexandersson. Data on specific emissions given in Alexandersson were mainly based on data from laboratory measurements by engine manufacturers but also measurements onboard three ships and other projects that has conducted measurements onboard sailing ships. Literature: Alexandersson, A. ''Sjöfartens utsläpp av avgaser'' TFB-meddelande nr 164, Transportforskningsdelegationen, Stockholm 1990. Lenner, M. ''Energiförbrukning och avgasemission för olika transporttyper'' VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 Planeringsunderlag för samordnad investeringsplanering 1994-2003. Statens	Output	Emission	NOx	1.18			g	Air	

Naturvårdsverk 1992-04-15 Notes:									
Notes:	Output	Emission	Particles	0.05			g	Air	
Date concieved: 1991 Data type: Unspecified Method: Exhaust emission factors in g/tonkm can be read in figure 25 in Alexandersson. To obtain emission factors in g/MJ, Tillman has divided the emission factors in g/tonkm with an energy use of 0,47 MJ/tonkm Figure 25 in Alexandersson is based on total exhaust emissions and transportation by domestic shipping in Sweden 1987. It is not however clear how the background data for figure 25 were collected. Literature: Alexandersson, A. ''Sjöfartens utsläpp av avgaser'' TFB-meddelande nr 164, Transportforskningsdelegationen, Stockholm 1990.	Output	Emission	SO2	0.6			g	Air	

About Inventory	
Publication	Tillman, A-M. `Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995 --- Documentation and review of the report done by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	To fulfil a need for *standard values* to calculate energy use and exhaust emissions from goods transports.
Detailed Purpose	An update of standard values for energy use and exhaust emissions from an earlier investigation in: *Tillman, A-M., Baumann, H., Eriksson, E., Rydberg, T.* `Livscykelanalyser för förpackningsmaterial - beräkning av miljöbelastning` SOU 1991:77, Allmänna förlaget, Stockholm, 1991.
Commissioner	- .
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	*Reviewers comment:* The data should be used with great care. The energy use for different types of ships can vary depending on e. g. size, shape of the hull, hydrodynamic properties and engine strength. This can give a very broad distribution in the energy use depending on which individual ships the energy use were based.
About Data	The emissions were calculated from the energy use and emission factors. The emission factors that were used and the basis for them can be found in general metadata.
Notes	

SPINE LCI dataset: Cold reducing of steel sheets

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System

Name	Cold reducing of steel sheets
Functional Unit	1 kg cold reduced steel sheet
Functional Unit Explanation	Before the steel can be coated, different pre treatments has to be done. The steel from the steel mill is first hot rolled and then pickled. After the pickling process, the steel is cold reduced and then finally coated.
Process Type	Unit operation
Site	SSAB Tunnplåt
Sector	Materials and components
Owner	SSAB Tunnplåt
Technical system description	This activity describes a process step included in the system ''Production of plywood boxes'', also available in the SPINE@CPM database. Plywood boxes are used to pack the coated and non-coated roller bearings from SKF, Göteborg, during the transportation to customers. The plywood boxes are manufactured by Nefab Emballage AB in Alfta, Sweden. The plywood box consist of plywood, steel strips, steel nails and wooden splits. The steel for the steel strips is hot rolled, pickled, cold reduced and finally coated at SSAB Tunnplåt`s line in Borlänge. This dataset describes the cold reducing of 1 kg pickled hot rolled steel sheet at SSAB Tunnplåt AB in Borlänge. This environmental profile refers to the mean values of emissions to which cold reducing lines give rise in the manufacturing of cold reduced rolled steel sheets at SSAB Tunnplåt AB in Borlänge during the years 1998-1999. All data for the process is obtained from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. The data refers to an existing EPD from SSAB Tunnplåt AB: Environmental Product Declaration from SSAB; SE 425; April 1999

System Boundaries

Nature Boundary	Emissions to air and water are included. The steel scrap from the process is reused as raw material and is thus not considered as waste, but as a co-product ending in the technosphere. For more detailed information see the EPD SE 425 from SSAB Tunnplåt AB.
Time Boundary	This environmental profile refers to the mean values of emissions to which cold reducing lines give rise in the manufacturing of cold reduced rolled steel sheets at SSAB Tunnplåt AB in Borlänge during the years 1998-1999. Changes in the process since then are not known.
Geographical Boundary	The process takes place at SSAB Tunnplåt AB in Borlänge, Sweden.
Other Boundaries	The production of electricity is NOT included in the dataset, but must be followed from the cradle in order to obtain the total environmental impact. For more detailed information see the EPD SE 425 from SSAB Tunnplåt AB.
Allocations	Allocations have been made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'
Method	The data is taken from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000.
Literature Reference	Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. Environmental Product Declaration from SSAB; SE 425; April 1999.
Notes	-

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Electricity	0.06			kWh	Technosphere	Sweden
	Input	Refined resource	Oil	0.5			g	Technosphere	Sweden
	Input	Refined resource	Pickled steel sheet	1.004			kg	Technosphere	Sweden
	Output	Co-product	Steel scrap	4.5			g	Technosphere	Sweden
	Output	Emission	Oil	0.1			mg	Water	Sweden
	Output	Emission	Oil	6			mg	Air	Sweden
	Output	Emission	P total	0.1			mg	Water	Sweden
	Output	Emission	Particles	0.2			mg	Water	Sweden
	Output	Product	Cold reduced steel sheet	1			kg	Technosphere	Sweden
	Output	Residue	Solid	0.1			g	Technosphere	Sweden

About Inventory	
Publication	Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. Both types of bearings are packed in a plywood box. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The dataset is applicable to cold reducing of steel sheets at SSAB Tunnplåt AB in Borlänge, Sweden.
About Data	All data for the process is obtained from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. The data refers to an existing EPD from SSAB Tunnplåt AB: Environmental Product Declaration from SSAB; SE 425; April 1999.
Notes	

SPINE LCI dataset: Collection area driving, with diesel driven waste collection vehicle. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Collection area driving, with diesel driven waste collection vehicle. ESA-DBP
Functional Unit	1 h of collection area driving
Functional Unit Explanation	1 hour of collection area driving on a typical waste collection route.

Process Type	Unit operation
Site	Gothenburg, Sweden
Sector	Land transport
Owner	Gothenburg, Sweden
Technical system description	Fuel demand and emissions during collection area driving with a diesel driven waste collection vehicle. Excerpt from the report (for report see link below): ''3.3 Use of the vehicle 3.3.1 Description of a typical waste collection route In the inventory description of the use phase the waste collection route is divided into three ''sub phases'', illustrated in Figure 8. Driving the vehicle from the garage to a waste collection area, between waste collection areas, to the incineration plant and back to the garage is in this report labelled transportation. Within a waste collection area the vehicle drives short distances between sites where waste is collected. This collection area driving is separated from the transportation to and from collection areas because it is another type of driving, generally much slower and with more acceleration and braking, which leads to other exhaust emissions. At the collection stops, waste bins are collected, the waste is loaded into the vehicle and it is then compacted. A conventional vehicle keeps the engine running at the stops, idling when the workers collect waste bins and working when loading and compacting waste. In a hybrid vehicle the engine is turned off 30 seconds after it has stopped, and the electric motor is then used for loading and compacting. Sometimes the loading and compacting procedure is carried through only once at a stop and sometimes a couple of times. After having collected all waste in one collection area, it might continue to another one, located some distance away, such as another city district. When the waste container of the vehicle is full, it is taken to the incineration plant, where it is emptied. Then it might go back to the garage or to another waste collection area to continue collecting waste.'' NB: Figure 8 in the text above is figure 8 at page 22 in the report. This process is included in the system described in ''Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	The measurements were made in the year 2004.
Geographical Boundary	The data are results from on board measurements made on a typicla waste collection route on a Volvo diesel waste collection vehicle and a Volvo hybrid waste collection vehicle in Gothenburg, Sweden.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Monitored data, discrete
Represents	See 'Function'.

Method	Excerpt from the report (for report see link in 'LitteratureRef'): ''Emissions and fuel consumption from simulated waste collection have been measured by the consultant firm Ecotraffic ERD3 AB together with Renova (Eriksson et al., 2004). On board measurements on a Volvo diesel vehicle and a Volvo hybrid (both of model FL6E) were used in this study.'' Time measurements, emission calculations and aother considerations when dealing with the fuel consumption simulation can be found in chapter 3.3 in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Typical collection area driving time: 503 seconds/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Diesel	7886			g	Technosphere	
	Output	Emission	CH4	0			g	Air	Sweden
	Output	Emission	CO	95.8			g	Air	Sweden
	Output	Emission	CO2	24104			g	Air	Sweden
	Output	Emission	Hydrocarbons	366.5			g	Air	Sweden
	Output	Emission	NOx	612.1			g	Air	Sweden
	Output	Emission	Particles	0.01485			g	Air	Sweden

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Process data in a Master Thesis Report.
Detailed Purpose	This process data set is a part of the comparative LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Renova AB - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpts from the report (for report see link in 'Publication'): ''For evaluation of a gas vehicle, measurements from the hybrid vehicle with the engine kept running at the stops were used. The values were also adjusted according to weight differences due to the extra hybrid electric equipment. The reason for not using data directly from a gas vehicle is because the gas vehicles Renova has is of an older model and have another engine type.'' ''Another important note is that the hybrid vehicle uses a catalytic converter that reduces methane emissions by 80 percent and the diesel vehicle uses a ''CRT particle filter'', which reduces emissions of particles, NOx and CO (Jensen, personal communication). The diesel vehicle fulfils the Euro 3 emission standards.'' ''Measurements were carried out during the different phases related to waste collection. While driving the vehicle at approximately constant speed, 50 km/h, transportation to and from a waste collection area was simulated. Waste collection within a collection area was simulated in a track where driving for 30 seconds followed by a 2 minutes 30 seconds stop for collection, loading and compacting. There are also measurements for idling and loading/compacting separated from the collection track. The measurements for transportation (to and from a collection area) are related to distance and the measurements for collection area driving and collection stop are related to time.'' ''To sum up, the times and distances are: Collection stop time: 1573 seconds/ton Collection area driving time: 503 seconds/ton Transportation distance, conventional vehicle: 4.67 km/ton Transportation distance, hybrid vehicle: 4.77 km/ton'' ''Emissions and resource use during electricity production were calculated using data for average Swedish electricity production (see section 3.1.2).'' NB: Section 3.1.2 is a section in the report.

	''Other energy carriers used include diesel, natural gas and fuel oil. Data about production of these were found in a study of production and use of several fuels (Uppenberg et al., 1999). Use of crude oil/natural gas as resource was not included in Uppenberg et al. Instead these resources used were assumed to be of the same amount as the fuel used (1 kg of crude oil for the use of 1 kg of fuel oil or diesel and 1 kg of natural gas for the use of 1 kg of natural gas as fuel). For a few processes, combustion of fuels (fuel oil, diesel and liquefied petroleum gas - LPG) was added using data from the energy and transport database included in LCAiT (CIT Ekologik, 2003). Also data for the production of LPG was taken from this database. Facts from Uppenberg et al. were also used to recalculate fuel amount between units of mass, volume and energy content.'' NB: Complete references to Uppenberg et al. (1999) and CIT Ekologik (2003) can be found in the report. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Collection area driving, with gas driven waste collection vehicle. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Collection area driving, with gas driven waste collection vehicle. ESA-DBP
Functional Unit	1 h of collection area driving
Functional Unit Explanation	1 hour of collection area driving on a typical waste collection route.
Process Type	Unit operation
Site	Gothenburg, Sweden
Sector	Land transport
Owner	Gothenburg, Sweden
Technical system description	Fuel demand and emissions during collection area driving with a gas driven waste collection vehicle. Excerpt from the report (for report see link below): ''3.3 Use of the vehicle 3.3.1 Description of a typical waste collection route In the inventory description of the use phase the waste collection route is divided into three ''sub phases'', illustrated in Figure 8. Driving the vehicle from the garage to a waste collection area, between waste collection areas, to the incineration plant and back to the garage is in this report labelled transportation. Within a waste collection area the vehicle drives short distances between sites where waste is collected. This collection area driving is separated from the transportation to and from collection areas because it is another type of driving, generally much slower and with more acceleration and braking, which leads to other exhaust emissions. At the collection stops, waste bins are collected, the waste is loaded into the vehicle and it is then compacted. A conventional

	vehicle keeps the engine running at the stops, idling when the workers collect waste bins and working when loading and compacting waste. In a hybrid vehicle the engine is turned off 30 seconds after it has stopped, and the electric motor is then used for loading and compacting. Sometimes the loading and compacting procedure is carried through only once at a stop and sometimes a couple of times. After having collected all waste in one collection area, it might continue to another one, located some distance away, such as another city district. When the waste container of the vehicle is full, it is taken to the incineration plant, where it is emptied. Then it might go back to the garage or to another waste collection area to continue collecting waste.'' NB: Figure 8 in the text above is figure 8 at page 22 in the report. This process is included in the system described in ''Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	The measurements were made in the year 2004.
Geographical Boundary	The data are results from on board measurements made on a typicla waste collection route on a Volvo diesel waste collection vehicle and a Volvo hybrid waste collection vehicle in Gothenburg, Sweden.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	Excerpt from the report (for report see link in 'LitteratureRef'): ''Emissions and fuel consumption from simulated waste collection have been measured by the consultant firm Ecotraffic ERD3 AB together with Renova (Eriksson et al., 2004). On board measurements on a Volvo diesel vehicle and a Volvo hybrid (both of model FL6E) were used in this study.'' Time measurements, emission calculations and aother considerations when dealing with the fuel consumption simulation can be found in chapter 3.3 in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Typical collection area driving time: 503 seconds/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Diesel	12810			g	Technosphere	
	Output	Emission	CH4	32.2			g	Air	Sweden
	Output	Emission	CO	53.4			g	Air	Sweden
	Output	Emission	CO2	34961			g	Air	Sweden

	Output	Emission	Hydrocarbons	9.9			g	Air	
	Output	Emission	NOx	174.2			g	Air	Sweden
	Output	Emission	Particles	0.5266			g	Air	Sweden

About Inventory	
Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Process data in a Master Thesis Report.
Detailed Purpose	This process data set is a part of the comparative LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Renova AB - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpts from the report (for report see link in 'Publication'): ''For evaluation of a gas vehicle, measurements from the hybrid vehicle with the engine kept running at the stops were used. The values were also adjusted according to weight differences due to the extra hybrid electric equipment. The reason for not using data directly from a gas vehicle is because the gas vehicles Renova has is of an older model and have another engine type.'' ''Another important note is that the hybrid vehicle uses a catalytic converter that reduces methane emissions by 80 percent and the diesel vehicle uses a ''CRT particle filter'', which reduces emissions of particles, NOx and CO (Jensen, personal communication). The diesel vehicle fulfils the Euro 3 emission standards.'' ''Measurements were carried out during the different phases related to waste collection. While driving the vehicle at approximately constant speed, 50 km/h, transportation to and from a waste collection area was simulated. Waste collection within a collection area was simulated in a track where driving for 30 seconds followed by a 2 minutes 30 seconds stop for collection, loading and compacting. There are also measurements for idling and loading/compacting separated from the collection track. The measurements for transportation (to and from a collection area) are related to distance and the measurements for collection area driving and collection stop are related to time.'' ''To sum up, the times and distances are: Collection stop time: 1573 seconds/ton Collection area driving time: 503 seconds/ton Transportation distance, conventional vehicle: 4.67 km/ton Transportation distance, hybrid vehicle: 4.77 km/ton'' ''Emissions and resource use during electricity production were calculated using data for average Swedish electricity production (see section 3.1.2).'' NB: Section 3.1.2 is a section in the report. ''Other energy carriers used include diesel, natural gas and fuel oil. Data about production of these were found in a study of production and use of several fuels (Uppenberg et al., 1999). Use of crude oil/natural gas as resource was not included in Uppenberg et al. Instead these resources used were assumed to be of the same amount as the fuel used (1 kg of crude oil for the use of 1 kg of fuel oil or diesel and 1 kg of natural gas for the use of 1 kg of natural gas as fuel). For a few processes, combustion of fuels (fuel oil, diesel and liquefied petroleum gas - LPG) was added using data from the energy and transport database included in LCAiT (CIT Ekologik, 2003). Also data for the production of LPG was taken from this database. Facts from Uppenberg et al. were also used to recalculate fuel amount between units of mass, volume and energy content.'' NB: Complete references to Uppenberg et al. (1999) and CIT Ekologik (2003) can be found in the report. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council.

	Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP
Functional Unit	1 h of collection area driving
Functional Unit Explanation	1 hour of collection area driving on a typical waste collection route.
Process Type	Unit operation
Site	Gothenburg, Sweden
Sector	Land transport
Owner	Gothenburg, Sweden
Technical system description	Fuel demand and emissions during collection area driving with a hybrid (gas-electric driven) waste collection vehicle. Excerpt from the report (for report see link below): ''3.3 Use of the vehicle 3.3.1 Description of a typical waste collection route In the inventory description of the use phase the waste collection route is divided into three ''sub phases'', illustrated in Figure 8. Driving the vehicle from the garage to a waste collection area, between waste collection areas, to the incineration plant and back to the garage is in this report labelled transportation. Within a waste collection area the vehicle drives short distances between sites where waste is collected. This collection area driving is separated from the transportation to and from collection areas because it is another type of driving, generally much slower and with more acceleration and braking, which leads to other exhaust emissions. At the collection stops, waste bins are collected, the waste is loaded into the vehicle and it is then compacted. A conventional vehicle keeps the engine running at the stops, idling when the workers collect waste bins and working when loading and compacting waste. In a hybrid vehicle the engine is turned off 30 seconds after it has stopped, and the electric motor is then used for loading and compacting. Sometimes the loading and compacting procedure is carried through only once at a stop and sometimes a couple of times. After having collected all waste in one collection area, it might continue to another one, located some distance away, such as another city district. When the waste container of the vehicle is full, it is taken to the incineration plant, where it is emptied. Then it might go back to the garage or to another waste collection area to continue collecting waste.'' NB: Figure 8 in the text above is figure 8 at page 22 in the report. This process is included in the system described in ''Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP

	Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	The measurements were made in the year 2004.
Geographical Boundary	The data are results from on board measurements made on a typicla waste collection route on a Volvo diesel waste collection vehicle and a Volvo hybrid waste collection vehicle in Gothenburg, Sweden.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	Excerpt from the report (for report see link in 'LitteratureRef'): ''Emissions and fuel consumption from simulated waste collection have been measured by the consultant firm Ecotraffic ERD3 AB together with Renova (Eriksson et al., 2004). On board measurements on a Volvo diesel vehicle and a Volvo hybrid (both of model FL6E) were used in this study.'' Time measurements, emission calculations and aother considerations when dealing with the fuel consumption simulation can be found in chapter 3.3 in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Typical collection area driving time: 503 seconds/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Diesel	16226			g	Technosphere	
	Output	Emission	CH4	71			g	Air	Sweden
	Output	Emission	CO	54.7			g	Air	Sweden
	Output	Emission	CO2	44259			g	Air	Sweden
	Output	Emission	Hydrocarbons	21			g	Air	Sweden
	Output	Emission	NOx	248.7			g	Air	Sweden
	Output	Emission	Particles	0.1475			g	Air	Sweden

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Process data in a Master Thesis Report.
Detailed Purpose	This process data set is a part of the comparative LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Renova AB - .
Practitioner	Anna Boss - .

Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpts from the report (for report see link in 'Publication'): ''For evaluation of a gas vehicle, measurements from the hybrid vehicle with the engine kept running at the stops were used. The values were also adjusted according to weight differences due to the extra hybrid electric equipment. The reason for not using data directly from a gas vehicle is because the gas vehicles Renova has is of an older model and have another engine type.'' ''Another important note is that the hybrid vehicle uses a catalytic converter that reduces methane emissions by 80 percent and the diesel vehicle uses a ''CRT particle filter'', which reduces emissions of particles, NOx and CO (Jensen, personal communication). The diesel vehicle fulfils the Euro 3 emission standards.'' ''Measurements were carried out during the different phases related to waste collection. While driving the vehicle at approximately constant speed, 50 km/h, transportation to and from a waste collection area was simulated. Waste collection within a collection area was simulated in a track where driving for 30 seconds followed by a 2 minutes 30 seconds stop for collection, loading and compacting. There are also measurements for idling and loading/compacting separated from the collection track. The measurements for transportation (to and from a collection area) are related to distance and the measurements for collection area driving and collection stop are related to time.'' ''To sum up, the times and distances are: Collection stop time: 1573 seconds/ton Collection area driving time: 503 seconds/ton Transportation distance, conventional vehicle: 4.67 km/ton Transportation distance, hybrid vehicle: 4.77 km/ton'' ''Emissions and resource use during electricity production were calculated using data for average Swedish electricity production (see section 3.1.2).'' NB: Section 3.1.2 is a section in the report. ''Other energy carriers used include diesel, natural gas and fuel oil. Data about production of these were found in a study of production and use of several fuels (Uppenberg et al., 1999). Use of crude oil/natural gas as resource was not included in Uppenberg et al. Instead these resources used were assumed to be of the same amount as the fuel used (1 kg of crude oil for the use of 1 kg of fuel oil or diesel and 1 kg of natural gas for the use of 1 kg of natural gas as fuel). For a few processes, combustion of fuels (fuel oil, diesel and liquefied petroleum gas - LPG) was added using data from the energy and transport database included in LCAiT (CIT Ekologik, 2003). Also data for the production of LPG was taken from this database. Facts from Uppenberg et al. were also used to recalculate fuel amount between units of mass, volume and energy content.'' NB: Complete references to Uppenberg et al. (1999) and CIT Ekologik (2003) can be found in the report. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Collection stop, with diesel driven waste collection vehicle. ESA-DBP

Administrative	
Finished	Y

Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Collection stop, with diesel driven waste collection vehicle. ESA-DBP
Functional Unit	1 h of collection stop
Functional Unit Explanation	1 hour of collection stop (idling and working) on a typical waste collection route.
Process Type	Unit operation
Site	Gothenburg, Sweden
Sector	Land transport
Owner	Gothenburg, Sweden
Technical system description	Fuel demand and emissions during collection stop with a diesel driven waste collection vehicle. Excerpt from the report (for report see link below): ''3.3 Use of the vehicle 3.3.1 Description of a typical waste collection route In the inventory description of the use phase the waste collection route is divided into three ''sub phases'', illustrated in Figure 8. Driving the vehicle from the garage to a waste collection area, between waste collection areas, to the incineration plant and back to the garage is in this report labelled transportation. Within a waste collection area the vehicle drives short distances between sites where waste is collected. This collection area driving is separated from the transportation to and from collection areas because it is another type of driving, generally much slower and with more acceleration and braking, which leads to other exhaust emissions. At the collection stops, waste bins are collected, the waste is loaded into the vehicle and it is then compacted. A conventional vehicle keeps the engine running at the stops, idling when the workers collect waste bins and working when loading and compacting waste. In a hybrid vehicle the engine is turned off 30 seconds after it has stopped, and the electric motor is then used for loading and compacting. Sometimes the loading and compacting procedure is carried through only once at a stop and sometimes a couple of times. After having collected all waste in one collection area, it might continue to another one, located some distance away, such as another city district. When the waste container of the vehicle is full, it is taken to the incineration plant, where it is emptied. Then it might go back to the garage or to another waste collection area to continue collecting waste.'' NB: Figure 8 in the text above is figure 8 at page 22 in the report. This process is included in the system described in ''Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries	
Nature Boundary	Not applicable.
Time Boundary	The measurements were made in the year 2004.
Geographical Boundary	The data are results from on board measurements made on a typicla waste collection route on a Volvo diesel waste collection vehicle and a Volvo hybrid waste collection vehicle in Gothenburg, Sweden.

Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	Excerpt from the report (for report see link in 'LitteratureRef'): ''Emissions and fuel consumption from simulated waste collection have been measured by the consultant firm Ecotraffic ERD3 AB together with Renova (Eriksson et al., 2004). On board measurements on a Volvo diesel vehicle and a Volvo hybrid (both of model FL6E) were used in this study.'' Time measurements, emission calculations and aother considerations when dealing with the fuel consumption simulation can be found in chapter 3.3 in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Typical collection stop time: 1573 seconds/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Diesel	2668			g	Technosphere	
	Output	Emission	CH4	0			g	Air	Sweden
	Output	Emission	CO	38.9			g	Air	Sweden
	Output	Emission	CO2	8203			g	Air	Sweden
	Output	Emission	Hydrocarbons	65.9			g	Air	Sweden
	Output	Emission	NOx	56.7			g	Air	Sweden
	Output	Emission	Particles	0.00351			g	Air	Sweden

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Process data in a Master Thesis Report.
Detailed Purpose	This process data set is a part of the comparative LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Renova AB - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpts from the report (for report see link in 'Publication'): ''For evaluation of a gas vehicle, measurements from the hybrid vehicle with the engine kept running at the stops were used. The values were also adjusted according to weight differences due to the extra hybrid electric equipment. The reason for not using data directly from a gas vehicle is because the gas vehicles Renova has is of an older model and have another engine type.'' ''Another important note is that the hybrid vehicle uses a catalytic converter that reduces methane emissions by 80 percent and the diesel vehicle uses a ''CRT particle filter'', which reduces emissions of particles, NOx and CO (Jensen, personal communication). The diesel vehicle fulfils the Euro 3 emission standards.'' ''Measurements were carried out during the different phases related to waste collection. While driving the vehicle at approximately constant speed, 50 km/h, transportation to and from a waste collection area was simulated. Waste collection within a collection

	area was simulated in a track where driving for 30 seconds followed by a 2 minutes 30 seconds stop for collection, loading and compacting. There are also measurements for idling and loading/compacting separated from the collection track. The measurements for transportation (to and from a collection area) are related to distance and the measurements for collection area driving and collection stop are related to time.'' ''To sum up, the times and distances are: Collection stop time: 1573 seconds/ton Collection area driving time: 503 seconds/ton Transportation distance, conventional vehicle: 4.67 km/ton Transportation distance, hybrid vehicle: 4.77 km/ton'' ''Emissions and resource use during electricity production were calculated using data for average Swedish electricity production (see section 3.1.2).'' NB: Section 3.1.2 is a section in the report. ''Other energy carriers used include diesel, natural gas and fuel oil. Data about production of these were found in a study of production and use of several fuels (Uppenberg et al., 1999). Use of crude oil/natural gas as resource was not included in Uppenberg et al. Instead these resources used were assumed to be of the same amount as the fuel used (1 kg of crude oil for the use of 1 kg of fuel oil or diesel and 1 kg of natural gas for the use of 1 kg of natural gas as fuel). For a few processes, combustion of fuels (fuel oil, diesel and liquefied petroleum gas - LPG) was added using data from the energy and transport database included in LCAiT (CIT Ekologik, 2003). Also data for the production of LPG was taken from this database. Facts from Uppenberg et al. were also used to recalculate fuel amount between units of mass, volume and energy content.'' NB: Complete references to Uppenberg et al. (1999) and CIT Ekologik (2003) can be found in the report. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Collection stop, with gas driven waste collection vehicle. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Collection stop, with gas driven waste collection vehicle. ESA-DBP
Functional Unit	1 h of collection stop
Functional Unit Explanation	1 hour of collection stop (idling and working) on a typical waste collection route.
Process Type	Unit operation
Site	Gothenburg, Sweden
Sector	Land transport

Owner	Gothenburg, Sweden
Technical system description	Fuel demand and emissions during collection stop with a gas driven waste collection vehicle. Excerpt from the report (for report see link below): ''3.3 Use of the vehicle 3.3.1 Description of a typical waste collection route In the inventory description of the use phase the waste collection route is divided into three ''sub phases'', illustrated in Figure 8. Driving the vehicle from the garage to a waste collection area, between waste collection areas, to the incineration plant and back to the garage is in this report labelled transportation. Within a waste collection area the vehicle drives short distances between sites where waste is collected. This collection area driving is separated from the transportation to and from collection areas because it is another type of driving, generally much slower and with more acceleration and braking, which leads to other exhaust emissions. At the collection stops, waste bins are collected, the waste is loaded into the vehicle and it is then compacted. A conventional vehicle keeps the engine running at the stops, idling when the workers collect waste bins and working when loading and compacting waste. In a hybrid vehicle the engine is turned off 30 seconds after it has stopped, and the electric motor is then used for loading and compacting. Sometimes the loading and compacting procedure is carried through only once at a stop and sometimes a couple of times. After having collected all waste in one collection area, it might continue to another one, located some distance away, such as another city district. When the waste container of the vehicle is full, it is taken to the incineration plant, where it is emptied. Then it might go back to the garage or to another waste collection area to continue collecting waste.'' NB: Figure 8 in the text above is figure 8 at page 22 in the report. This process is included in the system described in ''Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	The measurements were made in the year 2004.
Geographical Boundary	The data are results from on board measurements made on a typicla waste collection route on a Volvo diesel waste collection vehicle and a Volvo hybrid waste collection vehicle in Gothenburg, Sweden.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	Excerpt from the report (for report see link in 'LitteratureRef'): ''Emissions and fuel consumption from simulated waste collection have been measured by the consultant firm Ecotraffic ERD3 AB together with Renova (Eriksson et al., 2004). On board measurements on a Volvo diesel vehicle and a Volvo hybrid (both of model FL6E) were used in this study.'' Time measurements, emission calculations and aother considerations when dealing with the fuel consumption simulation can be found in chapter 3.3 in the report.

Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Typical collection stop time: 1573 seconds/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Diesel	3609			g	Technosphere	
	Output	Emission	CH4	11.1			g	Air	Sweden
	Output	Emission	CO	12.6			g	Air	
	Output	Emission	CO2	9849			g	Air	Sweden
	Output	Emission	Hydrocarbons	3.3			g	Air	Sweden
	Output	Emission	NOx	1.0			g	Air	Sweden
	Output	Emission	Particles	0.0141			g	Air	Sweden

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Process data in a Master Thesis Report.
Detailed Purpose	This process data set is a part of the comparative LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Renova AB - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpts from the report (for report see link in 'Publication'): ''For evaluation of a gas vehicle, measurements from the hybrid vehicle with the engine kept running at the stops were used. The values were also adjusted according to weight differences due to the extra hybrid electric equipment. The reason for not using data directly from a gas vehicle is because the gas vehicles Renova has is of an older model and have another engine type.'' ''Another important note is that the hybrid vehicle uses a catalytic converter that reduces methane emissions by 80 percent and the diesel vehicle uses a ''CRT particle filter'', which reduces emissions of particles, NOx and CO (Jensen, personal communication). The diesel vehicle fulfils the Euro 3 emission standards.'' ''Measurements were carried out during the different phases related to waste collection. While driving the vehicle at approximately constant speed, 50 km/h, transportation to and from a waste collection area was simulated. Waste collection within a collection area was simulated in a track where driving for 30 seconds followed by a 2 minutes 30 seconds stop for collection, loading and compacting. There are also measurements for idling and loading/compacting separated from the collection track. The measurements for transportation (to and from a collection area) are related to distance and the measurements for collection area driving and collection stop are related to time.'' ''To sum up, the times and distances are: Collection stop time: 1573 seconds/ton Collection area driving time: 503 seconds/ton Transportation distance, conventional vehicle: 4.67 km/ton Transportation distance, hybrid vehicle: 4.77 km/ton'' ''Emissions and resource use during electricity production were calculated using data for average Swedish electricity production (see section 3.1.2).'' NB: Section 3.1.2 is a section in the report. ''Other energy carriers used include diesel, natural gas and fuel oil. Data about production of these were found in a study of production and use of several fuels (Uppenberg et al., 1999). Use of crude oil/natural gas as resource was not included in Uppenberg et al. Instead these resources used were assumed to be of the same amount as the fuel used (1 kg of crude oil for the use of 1 kg of fuel oil or diesel and 1 kg of

	natural gas for the use of 1 kg of natural gas as fuel). For a few processes, combustion of fuels (fuel oil, diesel and liquefied petroleum gas - LPG) was added using data from the energy and transport database included in LCAiT (CIT Ekologik, 2003). Also data for the production of LPG was taken from this database. Facts from Uppenberg et al. were also used to recalculate fuel amount between units of mass, volume and energy content.'' NB: Complete references to Uppenberg et al. (1999) and CIT Ekologik (2003) can be found in the report. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP
Functional Unit	1 h of collection stop
Functional Unit Explanation	1 hour of collection stop (idling and working) on a typical waste collection route.
Process Type	Unit operation
Site	Gothenburg, Sweden
Sector	Land transport
Owner	Gothenburg, Sweden
Technical system description	Fuel demand and emissions during collection stop with a hybrid (gas-electric driven) waste collection vehicle. Excerpt from the report (for report see link below): ''3.3 Use of the vehicle 3.3.1 Description of a typical waste collection route In the inventory description of the use phase the waste collection route is divided into three ''sub phases'', illustrated in Figure 8. Driving the vehicle from the garage to a waste collection area, between waste collection areas, to the incineration plant and back to the garage is in this report labelled transportation. Within a waste collection area the vehicle drives short distances between sites where waste is collected. This collection area driving is separated from the transportation to and from collection areas because it is another type of driving, generally much slower and with more acceleration and braking, which leads to other exhaust emissions. At the collection stops, waste bins are collected, the waste is loaded into the vehicle and it is then compacted. A conventional vehicle keeps the engine running at the stops, idling when the workers collect waste bins and working when loading and compacting waste. In a hybrid vehicle the engine is turned off 30 seconds after it has stopped, and the electric motor is then used for loading and compacting. Sometimes the loading and compacting procedure is carried through only once at a stop and sometimes a couple of times.

	After having collected all waste in one collection area, it might continue to another one, located some distance away, such as another city district. When the waste container of the vehicle is full, it is taken to the incineration plant, where it is emptied. Then it might go back to the garage or to another waste collection area to continue collecting waste.'' NB: Figure 8 in the text above is figure 8 at page 22 in the report. This process is included in the system described in ''Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	The measurements were made in the year 2004.
Geographical Boundary	The data are results from on board measurements made on a typicla waste collection route on a Volvo diesel waste collection vehicle and a Volvo hybrid waste collection vehicle in Gothenburg, Sweden.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	Excerpt from the report (for report see link in 'LitteratureRef'): ''Emissions and fuel consumption from simulated waste collection have been measured by the consultant firm Ecotraffic ERD3 AB together with Renova (Eriksson et al., 2004). On board measurements on a Volvo diesel vehicle and a Volvo hybrid (both of model FL6E) were used in this study.'' Time measurements, emission calculations and aother considerations when dealing with the fuel consumption simulation can be found in chapter 3.3 in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Typical collection stop time: 1573 seconds/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Diesel	862			g	Technosphere	
	Output	Emission	CH4	2.7			g	Air	Sweden
	Output	Emission	CO	3.0			g	Air	Sweden
	Output	Emission	CO2	2351			g	Air	Sweden
	Output	Emission	Hydrocarbons	0.8			g	Air	Sweden
	Output	Emission	NOx	0.2			g	Air	Sweden
	Output	Emission	Particles	0.0034			g	Air	Sweden

About Inventory	
Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Process data in a Master Thesis Report.
Detailed Purpose	This process data set is a part of the comparative LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Renova AB - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpts from the report (for report see link in 'LitteratureRef'): ''For evaluation of a gas vehicle, measurements from the hybrid vehicle with the engine kept running at the stops were used. The values were also adjusted according to weight differences due to the extra hybrid electric equipment. The reason for not using data directly from a gas vehicle is because the gas vehicles Renova has is of an older model and have another engine type.'' ''Another important note is that the hybrid vehicle uses a catalytic converter that reduces methane emissions by 80 percent and the diesel vehicle uses a ''CRT particle filter'', which reduces emissions of particles, NOx and CO (Jensen, personal communication). The diesel vehicle fulfils the Euro 3 emission standards.'' ''Measurements were carried out during the different phases related to waste collection. While driving the vehicle at approximately constant speed, 50 km/h, transportation to and from a waste collection area was simulated. Waste collection within a collection area was simulated in a track where driving for 30 seconds followed by a 2 minutes 30 seconds stop for collection, loading and compacting. There are also measurements for idling and loading/compacting separated from the collection track. The measurements for transportation (to and from a collection area) are related to distance and the measurements for collection area driving and collection stop are related to time.'' ''To sum up, the times and distances are: Collection stop time: 1573 seconds/ton Collection area driving time: 503 seconds/ton Transportation distance, conventional vehicle: 4.67 km/ton Transportation distance, hybrid vehicle: 4.77 km/ton'' ''Emissions and resource use during electricity production were calculated using data for average Swedish electricity production (see section 3.1.2).'' NB: Section 3.1.2 is a section in the report. ''Other energy carriers used include diesel, natural gas and fuel oil. Data about production of these were found in a study of production and use of several fuels (Uppenberg et al., 1999). Use of crude oil/natural gas as resource was not included in Uppenberg et al. Instead these resources used were assumed to be of the same amount as the fuel used (1 kg of crude oil for the use of 1 kg of fuel oil or diesel and 1 kg of natural gas for the use of 1 kg of natural gas as fuel). For a few processes, combustion of fuels (fuel oil, diesel and liquefied petroleum gas - LPG) was added using data from the energy and transport database included in LCAiT (CIT Ekologik, 2003). Also data for the production of LPG was taken from this database. Facts from Uppenberg et al. were also used to recalculate fuel amount between units of mass, volume and energy content.'' NB: Complete references to Uppenberg et al. (1999) and CIT Ekologik (2003) can be found in the report. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).

Notes	Not applicable.

SPINE LCI dataset: Combined heat and power plant (CFB-KVV) with support systems

Administrative	
Finished	Y
Date Completed	1996-12-01
Copyright	
Availability	Public

Technical System	
Name	Combined heat and power plant (CFB-KVV) with support systems
Functional Unit	Net production of 1 kWh electricity
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the production of 1 kWh electricity.
Process Type	Cradle to gate
Site	
Sector	Grid electricity and district heat
Owner	
Technical system description	The studied system include *fuel production, operation and maintenance and handling of rest products of a combined heat and power plant with conventional steam cycle with a circulating fluidisation bed, equipped with flue gas condensing equipment (CFB-KVV)*. Production of materials, chemicals and electricity and transports, used in association with the fuel chain and the operation and maintenance of the plant are included. *The fuel is 100% fuel wood.* Fuel wood consists of splintered (flisade) felling rests such as branches and twigs from final cutting and small trees from thinning. Wood fuel is taken out as a by-product at final cutting, approximately every 80 years in the middle of Sweden. The fuel can also be extracted at thinning and clearing work. The fuel chain include collection and splintering (flisning) of felling rests, fuel transport and combustion and restoration of the ashes to the forest or field or to final waste. *Technical data* for the studied plant: Annual time of use (hours): 4400 Supplied fuel effect (MW): 33 Heat effect, net (MW): 21+6 where 6 MW refer to heat from flue gas condensation. Electric effect, net (MW): 9 Normal annual electricity production (GWh): 40 Assumed life-time (years): 40 Electricity production, net during 40 years (TWh): 1,6

System Boundaries	
Nature Boundary	In this study, fuel wood are used. The analysis starts at the *collection and splintering of felling rests.* The environmental influence of activities before collection and splintering (flisning) of felling rests, i.e. felling are excluded and has been allocated to the production of saw timber and pulp wood, since this takes place independent on the extraction of fuel. All emissions are considered equivalent, independent of where they take place (locally,

	regionally, globally; in densely populated areas or rural areas).
Time Boundary	The combined heat and power plant is assumed to have an operation time of 40 years.
Geographical Boundary	Sweden
Other Boundaries	The studied system include *fuel production, operation and maintenance and handling of rest products of a combined heat and power plant with conventional steam cycle with a circulating fluidisation bed, equipped with flue gas condensing equipment.* Calculations of building and demolition of the plant has been performed but are not included in this system. ***Sub-systems included in the system:*** • Collection and splintering of felling rests, fuel transport and combustion and restoration of the ashes to the forest or field or to final waste. • Use of resources and emissions associated with reinvestments and reconstruction. Concrete constructions and buildings are however not considered to need renewal during the lifetime of the power station. • Use of resources and emissions to air from production of the electricity that is used in the life cycles. • Energy use and emissions for the production of oil for the studied manufacturing processes and transports. • Known use of chemicals are accounted for. In the cases where it was possible to obtain data, resource use and emissions for the production are included. ***Sub-systems excluded from the system:*** • The part of fuel production, operation and rest products handling that can be assigned to heat production. The allocation principles are described under Allocation. • Equipment after the power station transformer. • The risk of major accidents and rare breakdowns and environmental consequences from these. • Work environment. • Environmental loads caused by the operation personnel. • Waste and rest products are transported to final waste. Operation and chemical and biological decomposing processes (nedbrytningsprocesser) in the final waste have not been considered.
Allocations	The *50/50 method* has been applied throughout the calculations. The method is described in ''Nordic Guidelines on Life-Cycle Assessment'', Nord 1995:20, The Nordic Council, Stockholm. For the combined heat and power plant, the production and transport of fuel, emissions from operation, use of chemicals at operation of the plant are *allocated in proportion to the production of heat and power (in kWh).* For operation and maintenance, including replacement of materials, the use of resources and emissions for components that are specific for the electricity production are allocated to the electricity production.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	See 'Function'.

Method	An LCA calculation of the fuel production, operation and maintenance and rest handling of a bio-fired combined heat and power plant.
Literature Reference	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', in Swedish, Vattenfall AB
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Forest land for fuel production and land for the power plant.	Input	Natural resource	Area	.066400			m2	Ground	
	Input	Natural resource	Bio fuel	.000001			kWh	Other	
	Input	Natural resource	Coal	.000171			kWh	Other	
	Input	Natural resource	Copper ore	.016000			g	Ground	
Notes: Fuel used for the operation of the power plant.	Input	Natural resource	Fuel wood	398.000000			g	Ground	
	Input	Natural resource	Iron ore	.048000			g	Ground	
	Input	Natural resource	Natural gas	.000048			kWh	Other	
Notes: Have not been traced back to the cradle.	Input	Refined resource	Ammonia	.005730			g	Technosphere	
Notes: Electricity produced by nuclear power. For the production of 1 kWh electricity in a nuclear power plant, 1,24 g uranium ore is used	Input	Refined resource	Electricity	.000006			kWh	Technosphere	
Notes: Electricity produced by water power.	Input	Refined resource	Electricity	.000007			kWh	Technosphere	
Notes: Includes oil, gasoline, diesel, lubricating and transformer oil.	Input	Refined resource	Heavy oil	.035400			kWh	Technosphere	
Notes: Have not been traced back to the cradle.	Input	Refined resource	NaOH	.006310			g	Technosphere	
Notes: There are data gaps e.g. the production of copper and cement.	Output	Emission	CO	.213000			g	Air	
Notes: CO2 from combustion of fuel wood (3,3e2 g/kWh electricity) is included. Considering the circulation of the bio fuel, this emission can be disregarded. The remaining CO2 emissions are 9,51e-2 g/kWh electricity.	Output	Emission	CO2	340.000000			g	Air	
Notes: Accounts for the total HC. There are data gaps for e.g. the production of copper and cement.	Output	Emission	HC	.014000			g	Air	
	Output	Emission	NOx	.333000			g	Air	
Notes: There are data gaps for e.g. manufacture of copper, cement and lubricating oil.	Output	Emission	N-tot	.016400			g	Water	
Notes: There are data gaps for e.g. the production of lubricating oil and personal transports.	Output	Emission	Particles	.029000			g	Air	
	Output	Emission	SO2	.041700			g	Air	
	Output	Product	Electricity	1.000000			kWh	Technosphere	
Notes: Includes rest products from manufacture of materials and replaced materials. There are data gaps.	Output	Residue	Other rest products	5.470000			g	Technosphere	

About Inventory

Publication	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology
Intended User	The data can be used as a basi
General Purpose	• The work with life-cycle analysis are expected to *contribute to a reinforcement and structuring* of the environmental work within Vattenfall, and a deeper knowledge on

	the use of resources and emissions to the environment. • An LCA can *facilitate a need for reliable data for electricity production.* Electricity is used in the manufacture of almost every product, and data from an LCA can be used when conducting an LCA on products. • An LCA can *facilitate a choice between different techniques* for future electricity production. • An LCA can also help to *choose the most effective alternatives* to reduce the consumption of resources and environmental influence of the current electricity production system. • It is also possible to *compare* the environmental load for different alternatives of electricity production.
Detailed Purpose	To obtain a *reliable basis* to be able to perform life-cycle analyses of different types of electricity use, and to identify opportunities for improvements in the existing system. To identify data gaps and areas where the knowledge are poor.
Commissioner	- Vattenfall Elproduktion .
Practitioner	- Vattenfall Energisystem AB: Britt-Marie Brännström-Norberg Ulrika Dethlefsen Roland Johansson Caroline Setterwall Sofie Tunbrant .
Reviewer	- Thomas Ekvall, Chalmers Industriteknik (CIT) Gunnar Lindfors, Institutet för Vatten- och Luftvårdsforskning (IVL) Göran Finnveden, Institutet för Vatten- och Luftvårdsforskning (IVL)
Applicability	The studied system include fuel production, operation and maintenance and handling of rest products of a combined heat and power plant with conventional steam cycle with a circulating fluidisation bed, equipped with flue gas condensing equipment (CFB-KVV). The fuel chain and combustion of fuel wood in a CFB-boiler should be *applicable on current bio-fired plants.* The calculations concern the *electricity production*. The use of resources and emissions from heat production can be calculated from these data. Combined heat and power are primarily used during the winter half, when the need for both heat and power are the largest. Transmission and distribution losses are not included. When the result is used to study different types of electricity use, these losses should be included. A rough estimate are that the distribution losses for a large industry customer are approximately 5% of the bought electricity, i.e. to obtain data for the use of electricity the data should be multiplied with 1,05. For an average household customer the transmission losses are approximately 10% of the bought electricity, i.e. the data should be multiplied with 1,10. The CFB-boiler are throughout the calculations assumed to be *equipped with flue gas condensing equipment.* If the results are applied to existing combined heat and power plants, the use of resources and emissions per produced kWh electricity will be higher, since a plant without flue gas condensing equipment have a lower total degree of efficiency. The fuel in this study is *100% fuel wood.* Fuel wood consists of splintered felling rests such as branches and twigs from final cutting and small trees from thinning. Wood fuel is taken out as a by-product at final cutting, approximately every 80 years in the middle of Sweden. The fuel can also be extracted at thinning and clearing work. Calculations for 100% salix (energy forest) fuel have been performed but are not reported. The *emission regulations* that are applied for the specific plant have a major influence on the emissions of NOx, N2O, NH3 and SO2. Fairly strict emission regulations have been chosen. The specific material use for a certain combustion technique and fuel are independent of where the plant is located. Other parameters can however vary, e.g. the transport distances. Data on the fuel use of *felling machinery and tractors* were collected a few years ago. The values are representative for the machines used today. New machines with better performance are being developed. The use of "old" data may give an overestimation of the calculated emissions from fuel production. The complete study include building, operation and maintenance, and demolition of the power plant and fuel production and handling of rest products from the fuel. When the

	data is used for energy production in a life cycle analysis of a product or a system, that do not require expansion of the electricity production system, it however reasonable only to include fuel production, operation and maintenance and handling of rest products from the fuel. The other phases of the life cycle are the same independent on the electricity production.
About Data	The plant studied, are a combined heat and power plant with a conventional steam cycle with a circulating fluidisation bed, equipped with flue gas condensing equipment (CFB-KVV). The fuel type and fuel handling are similar for a combined heat and power plant with a pressurised carburation combination cycle. The amount of supplied fuel and degree of efficiency however, varies. Data has been obtained from *existing plants* belonging to Vattenfall. The fuel is 100% fuel wood. Relevant data for transports, extraction and production of metals and chemicals, and manufacture and work on important components were hard to obtain. Data from manufacturers and other reports and studies, primarily life cycle analyses have been used. Production of material and transports are considered with current technology. Swedish standard values have been used to calculate fuel use and emissions from transports. Transport distances are specific for the operation of the plant. *The parameters that are presented* are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate. Data on the fuel use of felling machinery and tractors were collected a few years ago but are representative for the machines used today. Use of resources and emissions associated with *reinvestments and reconstruction are included*. They are generally assumed to give an addition of 1 % per year of the use of resources and emissions at the building phase. Concrete constructions and buildings are however not considered to need renewal during the lifetime of the power station. The following data has been used in the analysis (tonnes per year during 40 years) Steel: 1,70 Copper: 0,01 Brick: 0,10 Ammonia: 0,23 "Cyclohexylamin" 0,015 Hydrazine: 0,075 Sodium chloride: 0,25 The following *emission factors* have been used to calculate emissions from the operation of the plant. The emission factors are based on data from existing plants. NOx: 55 mg/MJ used fuel, 1,8e-1 g/kWh electricity SO2: 10 mg/MJ used fuel, 1,28e-1 g/kWh electricity CO: 50 mg/MJ used fuel, 1,60e-1 g/kWh electricity Particles: 5 mg/MJ used fuel, 1,60e-1 g/kWh electricity NH3: - mg/MJ used fuel, - g/kWh electricity N2O: 5 mg/MJ used fuel, 1,60e-2 g/kWh electricity CO2: 100000 mg/MJ used fuel, 3,30e2 g/kWh electricity For electricity used in the manufacture of materials and fuels, *average electricity* for the respective countries distributed on the different electricity production alternatives have been used. The following *degrees of efficiencies* have been used to calculate the fuel used in the electricity production. The values are standard values for existing power plants. New modern plants often have higher degrees of efficiencies. The values are calculated from the effective heat value in the used fuels and the energy content in the steam produced in a nuclear power plant. • Coal condensing: 40% • Oil condensing: 40% • Natural gas condensing/combination: 40% • Gas turbine: 25% • Combined heat and power plant(irrespective of fuel) 30% (for electricity production) 85% (total for electricity and heat production)

	• Water power: are not recalculated, are accounted for as kWh electricity • Nuclear power: 33%, are however not recalculated, but accounted for as kWh electricity or gram natural uranium.
Notes	When wood is extracted, nutritious substances, nitrogen and minerals are extracted at the same time. They would otherwise have been supplied to the forest when the tree dies and are decomposed. The content of nutritious substances are higher in branches and treetops than in the trunk wood. Extraction of felling rests influences the mineral balance negatively. The return of ashes are therefore considered to be a condition for an extensive use of wood fuel. Extraction of nitrogen in combination with return of nutritious substances, e.g. in association with ashes are estimated to give an relief to nitrogen rich forest systems and are estimated to bring about an increased resistance against acidification. Final cutting has a large influence on the landscape through clear-cut forests. The extraction of wood fuel then often has a positive effect on the landscape. Combined heat and power are used as base primarily during the winter half, when the need for both heat and power are the largest.

SPINE LCI dataset: Combined heat and power plant (GCC-KVV) with support systems

Administrative	
Finished	Y
Date Completed	1996-12-01
Copyright	
Availability	Public

Technical System	
Name	Combined heat and power plant (GCC-KVV) with support systems
Functional Unit	Net production of 1 kWh electricity
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh electricity.
Process Type	Cradle to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	The studied system include *fuel production, operation and maintenance and handling of rest products of a combined heat and power plant with a with a pressurised carburation and combination cycle (GCC-KVV).* At the carburation, a fuel gas are produced with a heating value high enough to be combusted in a gas turbine burner. The plant has a higher degree of efficiency than conventional bio-fired plants. Production of materials, chemicals and electricity and transports, used in association with the fuel chain and the operation and maintenance of the plant are included. *The fuel is 100% fuel wood.* Fuel wood consists of splintered felling rests such as branches and twigs from final cutting and small trees from thinning. Wood fuel is taken out as

	a by-product at final cutting, approximately every 80 years in the middle of Sweden. The fuel can also be extracted at thinning and clearing work. The fuel chain include collection and splintering of felling rests, fuel transport and combustion and restoration of the ashes to the forest or field or to final waste. *Technical data* for the studied plant: Annual time of use (hours): 4400 Supplied fuel effect (MW): 140 Heat effect, net (MW): 60 Electric effect, net (MW): 59 Normal annual electricity production (GWh): 260 Assumed life-time (years): 40 Electricity production, net during 40 years (TWh): 10,4

System Boundaries	
Nature Boundary	In this study, fuel wood are used. The analysis starts at the *collection and splintering of felling rests.* The environmental influence of activities before collection and splintering (flisning) of felling rests, i.e. felling are excluded and has been allocated to the production of saw timber and pulp wood, since this takes place independent on the extraction of fuel. All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The combined heat and power plant is assumed to have an operation time of 40 years.
Geographical Boundary	Sweden
Other Boundaries	The studied system include *fuel production, operation and maintenance and handling of rest products of a combined heat and power plant with a with a pressurised carburation and combination cycle.* Calculations of building and demolition of the plant has been performed but are not included in this system. ***Sub-systems included in the system:*** • Collection and splintering (flisning) of felling rests, fuel transport and combustion and restoration of the ashes to the forest or field or to final waste. • Use of resources and emissions associated with reinvestments and reconstruction. Concrete constructions and buildings are however not considered to need renewal during the lifetime of the power station. • Known use of chemicals are accounted for. In the cases where it was possible to obtain data, resource use and emissions for the production are included. • Use of resources and emissions to air from production of the electricity that is used in the life cycles. • Energy use and emissions for the production of oil for the studied manufacturing processes and transports. ***Sub-systems excluded from the system:*** • The part of fuel production, operation and rest products handling that can be assigned to heat production. The allocation principles are described under Allocation. • Equipment after the power station transformer. • Waste and rest products are transported to final waste. Operation and chemical and biological decomposing processes (nedbrytningsprocesser) in the final waste have not been considered. • The risk of major accidents and rare breakdowns and environmental consequences from these. • Work environment.

	• Environmental loads caused by the operation personnel.
Allocations	The *50/50 method* has been applied throughout the calculations. The method is described in ''Nordic Guidelines on Life-Cycle Assessment'', Nord 1995:20, The Nordic Council, Stockholm. For the combined heat and power plant, the production and transport of fuel, emissions from operation, use of chemicals at operation of the plant are *allocated in proportion to the production of heat and power (in kWh).* For operation and maintenance, including replacement of materials, the use of resources and emissions for components that are specific for the electricity production are allocated to the electricity production.
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study)

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	An LCA calculation of the fuel production, operation and maintenance and handling of rest products of a bio-fired combined heat and power plant with pressurised carburation and combination cycle.
Literature Reference	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', in Swedish, Vattenfall AB
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Forest land for fuel production and land for the power plant.	Input	Natural resource	Area	.085300			m2	Ground	
	Input	Natural resource	Bauxite	.000129			g	Ground	
	Input	Natural resource	Copper ore	.000306			g	Ground	
Notes: Fuel used for the operation of the power plant.	Input	Natural resource	Fuel wood	512.000000			g	Ground	
	Input	Natural resource	Iron ore	.080600			g	Ground	
Notes: Have not been traced back to the cradle.	Input	Refined resource	Ammonia	.001190			g	Technosphere	
	Input	Refined resource	Bio fuel	.000001			kWh	Technosphere	
	Input	Refined resource	Coal	.000291			kWh	Technosphere	
Notes: Electricity produced by nuclear power. For the production of 1 kWh electricity in a nuclear power plant, 1,24 g uranium ore is used	Input	Refined resource	Electricity	.000126			kWh	Technosphere	
Notes: Electricity produced by water power	Input	Refined resource	Electricity	.000160			kWh	Technosphere	
Notes: Includes oil, gasoline, diesel, lubricating and transformer oil.	Input	Refined resource	Heavy oil	.046000			kWh	Technosphere	
Notes: Have not been traced back to the cradle.	Input	Refined resource	NaOH	.084100			g	Technosphere	
	Input	Refined resource	Natural gas	.000016			kWh	Technosphere	
Notes: There are data gaps e.g. the production of copper and cement.	Output	Emission	CO	.105000			g	Air	
Notes: CO2 from combustion of fuel wood (4,24e2 g/kWh electricity) is included. Considering the circulation of the bio fuel, this emission can be disregarded. The remaining CO2 emissions are 3,52e-1 g/kWh electricity.	Output	Emission	CO2	437.000000			g	Air	

Notes: Accounts for the total HC. There are data gaps for e.g. the production of copper and cement.	Output	Emission	HC	.018100			g	Air	
	Output	Emission	NOx	.410000			g	Air	
Notes: There are data gaps for e.g. manufacture of copper, cement and lubricating oil.	Output	Emission	N-tot	.020000			g	Water	
Notes: There are data gaps for e.g. the production of lubricating oil and personal transports.	Output	Emission	Particles	.037700			g	Air	
	Output	Emission	SO2	.181000			g	Air	
	Output	Product	Electricity	1.000000			kWh	Technosphere	
Notes: Includes rest products from manufacture of materials and replaced materials. There are data gaps.	Output	Residue	Other rest products	10.000000			g	Technosphere	

About Inventory

Publication	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	The data can be used as a basi
General Purpose	• The work with life-cycle analysis are expected to *contribute to a reinforcement and structuring* of the environmental work within Vattenfall, and a deeper knowledge on the use of resources and emissions to the environment. • An LCA can *facilitate a need for reliable data for electricity production.* Electricity is used in the manufacture of almost every product, and data from an LCA can be used when conducting an LCA on products. • An LCA can *facilitate a choice between different techniques* for future electricity production. • An LCA can also help to *choose the most effective alternatives* to reduce the consumption of resources and environmental influence of the current electricity production system. • It is also possible to *compare* the environmental load for different alternatives of electricity production.
Detailed Purpose	To obtain a *reliable basis* to be able to perform life-cycle analyses of different types of electricity use, and to identify opportunities for improvements in the existing system. To identify data gaps and areas where the knowledge are poor.
Commissioner	- Vattenfall Elproduktion .
Practitioner	- Vattenfall Energisystem AB: Britt-Marie Brännström-Norberg Ulrika Dethlefsen Roland Johansson Caroline Setterwall Sofie Tunbrant .
Reviewer	- Thomas Ekvall, Chalmers Industriteknik (CIT) Gunnar Lindfors, Institutet för Vatten- och Luftvårdsforskning (IVL) Göran Finnveden, Institutet för Vatten- och Luftvårdsforskning (IVL)
Applicability	The studied system includes fuel production, operation and maintenance and handling of rest products of a combined heat and power plant with a with a pressurised carburation and combination cycle, which indicates that the results primarily are *applicable for VattenfallÆs future bio-fired combined heat and power plants.* Parts of the analysis, predominantly the fuel chain, should however be applicable on current bio-fired plants. The calculations concern the *electricity production.* The use of resources and emissions from the heat production can however be calculated from these data. Combined heat and power plants are primarily used during the winter half, when the need for both heat and power are the largest. Transmission and distribution losses are not included. When the result is used to study different types of electricity use, these losses should be included. A rough estimate are that the distribution losses for a large industry customer are approximately 5% of the bought electricity, i.e. to obtain data for the use of electricity the data should be multiplied with 1,05. For an average household customer the transmission losses are approximately 10% of the bought electricity, i.e. the data should be multiplied with 1,10. The fuel in this study is *100% fuel wood.* Fuel wood consists of splintered (flisade) felling rests such as branches and twigs from final cutting and small trees from thinning. Wood fuel is taken out as a by-product at final cutting, approximately every 80 years in the middle of

Sweden. The fuel can also be extracted at thinning and clearing work. Calculations for 100% salix (energy forest) fuel have been performed but are not reported.

The *emission regulations* that are applied for the specific plant have a major influence on the emissions of NOx, N2O, NH3 and SO2. Fairly strict emission regulations have been chosen. The specific material use for a certain combustion technique and fuel are independent of where the plant is located. Other parameters can however vary e.g. the transport distances.

Data on the fuel use of *felling machinery and tractors* were collected a few years ago. The values are representative for the machines used today. New machines with better performance are being developed. The use of ''old'' data may give an overestimation of the calculated emissions from fuel production.

The complete study include building, operation and maintenance, and demolition of the power plant and fuel production and handling of rest products from the fuel. When the data is used for energy production in a life cycle analysis of a product or a system, that do not require expansion of the electricity production system, it however reasonable only to include fuel production, operation and maintenance and handling of rest products from the fuel. The other phases of the life cycle are the same independent on the electricity production.

About Data

The plant studied is a combined heat and power plant with a pressurised carburation and combination cycle (GCC-KVV). The plant has a higher degree of efficiency than conventional bio-fired plants. Data has been obtained from one of Vattenfall:s prospected plants. The fuel is 100% fuel wood.

Relevant data for transports, extraction and production of metals and chemicals, and manufacture and work on important components were hard to obtain. Data from manufacturers and other reports and studies, primarily life cycle analyses have been used. Production of material and transports are considered with current technology. Swedish standard values have been used to calculate fuel use and emissions from transports. Transport distances are specific for the operation of the plant.

The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Data on the fuel use of felling machinery and tractors were collected a few years ago but are representative for the machines used today.

Use of resources and emissions associated with *reinvestments and reconstruction are included*. They are generally assumed to give an addition of 1 % per year of the use of resources and emissions at the building phase. Concrete constructions and buildings are however not considered to need renewal during the lifetime of the power station. The following data has been used in the analysis (tonnes per year during 40 years):
Steel: 18,70
Copper: 0,30
Stone wool: 0,40
Aluminium: 0,04
Brick: 2,50
Titanium dioxide: 0,11
Ammonia: 0,31
Hydrazine: 0,31
Hydrochloric acid: 21,80
Sodium hydroxide: 21,80
"trinatriumfosfat" 0,18
Lubricating oil: 0,94
Dolomite: 1,18

The following *emission factors* have been used to calculate emissions from operation of the plant. The emission factors are based on data from measurements at trial runs at a 15 MW (thermal effect) experimental plant.
NOx: 50 mg/MJ used fuel, 2,1e-1 g/kWh electricity
SO2: 40 mg/MJ used fuel, 1,69e-1 g/kWh electricity
CO: 10 mg/MJ used fuel, 4,20e-2 g/kWh electricity
Particles: 5 mg/MJ used fuel, 2,10e-1 g/kWh electricity
NH3: 5 ppm mg/MJ used fuel, 3,30e-2 g/kWh electricity
N2O: - mg/MJ used fuel, - g/kWh electricity
CO2: 100000 mg/MJ used fuel, 4,24e2 g/kWh electricity

For electricity used in the manufacture of materials and fuels, *average electricity* for the respective countries distributed on the different electricity production alternatives have been used. The following *degrees of efficiencies* have been used to calculate the fuel used in the electricity production. The values are standard values for existing power plants. New modern plants often have higher degrees of efficiencies. The values are calculated from the effective heat

	value in the used fuels and the energy content in the steam produced in a nuclear power plant. • Coal condensing: 40% • Oil condensing: 40% • Natural gas condensing/combination: 40% • Gas turbine: 25% • Combined heat and power plant(irrespective of fuel) 30% (for electricity production) 85% (total for electricity and heat production) • Water power: are not recalculated, are accounted for as kWh electricity • Nuclear power: 33%, are however not recalculated, but accounted for as kWh electricity or gram natural uranium.
Notes	When wood is extracted, nutritious substances, nitrogen and minerals are extracted at the same time. They would otherwise have been supplied to the forest when the tree dies and are decomposed. The content of nutritious substances are higher in branches and treetops than in the trunk wood. Extraction of felling rests influences the mineral balance negatively. The return of ashes are therefore considered to be a condition for an extensive use of wood fuel. Extraction of nitrogen in combination with return of nutritious substances, e.g. in association with ashes are estimated to give an relief to nitrogen rich forest systems and are estimated to bring about an increased resistance against acidification. Final cutting has a large influence on the landscape through clear-cut forests. The extraction of wood fuel then often has a positive effect on the landscape. Combined heat and power are used as base primarily during the winter half, when the need for both heat and power are the largest.

SPINE LCI dataset: Combustion of bio fuel

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	Public

Technical System	
Name	Combustion of bio fuel
Functional Unit	1 MJ
Functional Unit Explanation	1MJ bio fuel.
Process Type	Gate to gate
Site	Sweden
Sector	Energyware

Owner	Sweden
Technical system description	Combustion of bio fuel at a stationary installation.

System Boundaries	
Nature Boundary	The emissions to air are the only parameters that are studied. No carbon dioxide emissions are accounted to the burning of bio fuels, since the amount of carbon dioxide released in the combustion of biomass was absorbed by the biomass during its lifetime.
Time Boundary	The data are based on conditions and the environmental law valid for 1990.
Geographical Boundary	
Other Boundaries	The bio gas that is incinerated is accounted for.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1991
Data Type	Unspecified
Represents	See 'Function'.
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Bio fuel	1			MJ	Technosphere	
Method: The ash content in wood is 7-15 % by weight. In this case the figure is set to 2%, which is equivalent to 0,10 g/MJ.	Output	Emission	Ash	0.10			g	Air	
Method: According to the Swedish Environmental Protection Board, 0,30-2,00 g CO/MJ applies for wood burnt on a grate, while Bundesamt furUmwelt uses 0,980 g/MJ for wood. In this case the figure 1,00 g/MJ is used.	Output	Emission	CO	1.00			g	Air	
Method: According to the Swedish Environmental Protection Board, 0,007-0,100 g/MJ applies for wood burnt on a grate, while Bundesamt furUmwelt uses 0,176 g/MJ for wood. In this case the figure 0,10 g/MJ is used.	Output	Emission	HC	0.10			g	Air	
Method: According to the Swedish Environmental Protection Board, less than 0,15 g NOx/MJ should be emitted when wood is burnt on a grate, and that the emissions should be comparable in amount with those which occur during the combustion of oil. In this case the figure 0,15 g/MJ is used.	Output	Emission	NOx	0.15			g	Air	
	Output	Emission	Particulates	0.03			g	Air	
Method: According to the law and regulations governing fuels containing sulphur, from 1989, the emission maximum for sulphur is 0.19 sulphur/MJ fuel consumed. This is equivalent to 0,38 g SO2/MJ. For biofuel a figure of 0,031 g SO2/MJ is given in Project kol-Hälsa_Miljö,	Output	Emission	SO2	0.03			g	Air	

''Kolets hälso och miljöeffekter, Vattenfall, 1989.									

About Inventory	
Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data are parts of an inquest about ''Packing and the Environment''.
Detailed Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	- .
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air caused by combustion of bio fuel at a stationary installation (for exemple an bio fuel driven power plant). The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unrelyable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system. One of the most important things to know is the efficiency of the plant but even this information is missing.
About Data	
Notes	

SPINE LCI dataset: Combustion of coal

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	Public

Technical System	
Name	Combustion of coal
Functional Unit	1 MJ
Functional Unit Explanation	1MJ coal.
Process Type	Gate to gate
Site	Sweden

Sector	Energyware
Owner	Sweden
Technical system description	Combustion of coal at a stationary installation.

System Boundaries	
Nature Boundary	The emissions to air are the only parameters that are studied.
Time Boundary	The data are based on conditions and the environmental law valid for 1990.
Geographical Boundary	
Other Boundaries	The coal that is combusted is accounted for.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1991
Data Type	Unspecified
Represents	See 'Function'.
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Ryden, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Coal	1			MJ	Technosphere	
Method: The ash content in oil is 7-15 % by weight. In this case the figure is set to 8%, which is equivalent to 0,3 g/MJ.	Output	Emission	Ash	0.30			g	Air	
Method: In 1985 the German environmental agency Umweltsbundesamt (UBA) states 0,017g CO/MJ for oil combustion	Output	Emission	CO	0.017			g	Air	
Method: The carbon dioxide has been calculated from the content and calofific value of the fuel. For coal a figure of 91,6 g CO2/MJ is obtained.	Output	Emission	CO2	91.6			g	Air	
Method: According to UBA (Umweltsbundesamt) coal combustion results in hydrocarbon emissions of 0,003 g/MJ. Bundesamt fur Umwelt quotes figures of 0,017 g HC/MJ. The figure 0,01 g/MJ is used here.	Output	Emission	HC	0.010			g	Air	
Method: Emissions of nitrogen oxides are not subject to a special regulation, though guidelines exist, which are used for review purposes in conection with the Environmental Protection Act and the Natural Resources Act. The current guideline is 0,05 g/MJ for combustion of coal in a smaller, new installation. The figure 0,15 g NOx is used.	Output	Emission	NOx	0.15			g	Air	
	Output	Emission	Particulates	0.013			g	Air	

Method: According to the law and regulations governing fuels containing sulphur, from 1989, the emission maximum for sulphur is 0.19 sulphur/MJ fuel consumed. This is equivalent to 0,38 g SO2/MJ, which is used for coal.	Output	Emission	SO2	0.38			g	Air	

About Inventory	
Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. --- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology ---
Intended User	A Life Cycle Assessment practi
General Purpose	The data are parts of an inquest about ''Packing and the Environment''.
Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	- .
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air caused by combustion of coal at a stationary installation (for exemple an coal driven power plant). The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unrelyable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system. One of the most important things to know is the efficiency of the plant but even this information is missing.
About Data	
Notes	

SPINE LCI dataset: Combustion of natural gas

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	Public

Technical System	
Name	Combustion of natural gas
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ natural gas.

Process Type	Gate to gate
Site	Sweden
Sector	Energyware
Owner	Sweden
Technical system description	Combustion of natural gas at a stationary installation.

System Boundaries

Nature Boundary	The emissions to air are the only parameters that are studied.
Time Boundary	The data are based on conditions and the environmental law valid for 1990.
Geographical Boundary	
Other Boundaries	The natural gas that is combusted is accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991
Data Type	Unspecified
Represents	See 'Function'.
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Natural gas	1			MJ	Technosphere	
Method: The figure 0,001 g CO/MJ, for combustion of natural gas, for industrial use, comes from Vattenfall, ''Natur gas - Hälsa Miljö'', 1984	Output	Emission	CO	0.001			g	Air	
Method: The carbon dioxide has been calculated from the content and calofific value of the fuel. For natural gas a figure of 55,2 g CO2/MJ is obtained.	Output	Emission	CO2	55.2			g	Air	
Method: The figure 0,000015 g HC/MJ, for combustion of natural gas, for industrial use, comes from Vattenfall, ''Natur gas - Hälsa Miljö'', 1984	Output	Emission	HC	0.000015			g	Air	
Method: 0,07 g NOx/MJ is generated in natural gas furnaces with a consumption above 50 MW and 0,2g NOx/MJ in furnaces with a consumption over 50MW, the figures come from Vattenfall, ''Natur gas - Hälsa Miljö'', 1984. The figure 0,15 g NOx/MJ is used here.	Output	Emission	NOx	0.15			g	Air	
Method: According to the law and regulations governing fuels containing sulphur, from 1989, the emission maximum for sulphur is 0.19 sulphur/MJ fuel consumed. This is equivalent to 0,38 g SO2/MJ. The maximum value is not used for natural gas. Natural gas contains 0,001 s sulphur /MJ, which equals to 0,002 g SO2/MJ. These figures are taken from Vattenfall, ''Natur gas - Hälsa Miljö'', 1984	Output	Emission	SO2	0.002			g	Air	

About Inventory	
Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data are parts of an inquest about ''Packing and the Environment''.
Detailed Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	- .
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air caused by combustion of natural gas at a stationary installation (for exemple an natural gas driven power plant). The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this, one gets an unrelyable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system. One of the most important things to know is the efficiency of the plant but even this information is missing.
About Data	
Notes	

SPINE LCI dataset: Combustion of oil

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	Public

Technical System	
Name	Combustion of oil
Functional Unit	1 MJ
Functional Unit Explanation	1MJ oil
Process Type	Gate to gate
Site	Sweden
Sector	Energyware

Owner	Sweden
Technical system description	Combustion of oil at a stationary installation.

System Boundaries

Nature Boundary	The emissions to air are the only parameters that are studied.
Time Boundary	The data are based on conditions and the environmental law valid for 1990.
Geographical Boundary	
Other Boundaries	The oil that is combusted is accounterd for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991
Data Type	Unspecified
Represents	See 'Function'.
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Represents: Oil in general terms. No differense is made between different types of oil.	Input	Refined resource	Oil	1			MJ	Technosphere	
Method: The ash content in oil is 0,01-0,1 % by weight. In this case the figure is set to 0,03%, which is equivalent to 0,007 g/MJ.	Output	Emission	Ash	0.007			g	Air	
Method: In 1985 the German environmental agency Umweltsbundesamt (UBA) states 0,013 g CO/MJ for oil combustion	Output	Emission	CO	0.013			g	Air	
Method: The carbon dioxide has been calculated from the content and calofific value of the fuel. For oil a figure of 75,8 g CO2/MJ is obtained.	Output	Emission	CO2	75.8			g	Air	
Method: According to UBA (Umweltsbundesamt) oil combustion results in hydrocarbon emissions of 0,003 g/MJ. Bundesamt fur Umwelt quotes figures of 0,01 g HC/MJ. The figure 0,01 g/MJ is used here.	Output	Emission	HC	0.010			g	Air	
Method: Emissions of nitrogen oxides are not subject to a special regulation, though guidelines exist, which are used for review purposes in conection with the Environmental Protection Act and the Natural Resources Act. The current guidelines are 0,05-0,10 g/MJ for large, new installations and 0,10-0,20 g/MJ for smaller, new installations. The figure 0,15 g NOx is used.	Output	Emission	NOx	0.15			g	Air	
Method: In the case of particulate emissions the figure given in the guidelines for heavy combustion oil at installations larger than 300 MW is 1,0 particulates/kg oil, which is equivalent to 0,024 g/MJ. The figure for smaller-sized installations is 1,5	Output	Emission	Particulates	0.03			g	Air	

g/kg oil, equivalent to 0,037 g/MJ. Based on this the figure 0,030 g/MJ is chosen.									
Method: According to the law and regulations governing fuels containing sulphur, from 1989, the emission maximum for sulphur is 0.19 sulphur/MJ fuel consumed. This is equivalent to 0,38 g SO2/MJ, which is used for oil.	Output	Emission	SO2	0.38			g	Air	

About Inventory	
Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data are parts of an inquest about ''Packing and the Environment''.
Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	- .
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air caused by combustion of oil at a stationary installation (for exemple an oil driven power plant). The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this one gets an unrelyable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system. One of the most important things to know is the efficiency of the plant but even this information is missing.
About Data	The data represents incineration of oil in general terms. No difference is made between different types of oil.
Notes	

SPINE LCI dataset: Combustion of waste

Administrative	
Finished	Y
Date Completed	1999-04-19
Copyright	
Availability	public

Technical System	
Name	Combustion of waste
Functional Unit	1 m3 of scrap recieved from Reci Industri Göteborg.

Functional Unit Explanation	See detailed purpose.
Process Type	Gate to grave
Site	GRAAB Box 156 401 22 Göteborg Sweden
Sector	Waste treatment
Owner	GRAAB Box 156 401 22 Göteborg Sweden
Technical system description	At the waste fuelled power plant in Sävenäs about 400.000 tonnes of waste is combusted every year. The energy production per year is about 1 040 GWh heat and 130 GWh electricity. The waste is transported to the facility by truck (Transportation not included in the system). A manually manoeuvred crane feeds the roaster-furnace with waste. The waste is fed on the roaster during the combustion process and the burned-out slag falls down into a water filled slag-distinguishing-basin. The slag is after cooling transported to a deposit-site. The kiln is provided with smoke re-feeder to cut the emissions of especially NOx. To further increase the reduction of NOx, ammonia solution is added during the combustion. The emitted smoke from the combustion is led via a boiler to different steps of smoke purification where heat is extracted. At one step in the smoke purification the smoke is cleansed with water which leaves some of the emissions in a water phase. The polluted water is send to a water cleaning facility before it is let out into Säveån.

System Boundaries	
Nature Boundary	Resources that are not seen as limited in Sweden are neglected e.g. land usage and fresh water. · The electricity utilised by the system is only seen as a resource and the origin is not interpreted. The company is legislated to measure the following emissions: CO Particles NOx HCl Hg Cd Cr Ni Co Pb Dioxin
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary for the converting of waste-oil is set to Sweden.
Other Boundaries	The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. It is assumed that there occurs no spill at the plant.
Allocations	Only impacts caused by the combustion of scrap from Reci Industri are of interest for the study. At Sävenäs various kinds of waste is combusted. It is in many cases impossible to determine its composition. Only the scrap from Reci is of interest, but as it is mixed with other wastes while combusted it is difficult to determine the origin of emissions and what waste contributes to what emission and resource use. The scrap from Reci is in its turn of unknown composition and is only a smaller part of the total amount combusted (160 of totally 381 379 tonnes). The allocation approach is to load emissions and resource use to the scrap based on weight. A deviation to the approach is made concerning the use of fuel oil (Eo4), as the scrap contains fuel oil itself it is not likely to need additional fuel oil to initiate the combustion process. The amount of the heavy metals Co, Be and As in the waste-oil are supposed to be so low that they can be neglected .
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1997
Data Type	Unspecified
Represents	See 'Function'.

Method	The general description of the plant is taken from the environmental report of 1997 for GRAAB. Information about the scrap delivered to Sävenäs from Reci is achieved from interviews with Christian Artén, process manager at Reci Göteborg and Bengt Borg production manager at Reci Halmstad. The substances are divided with the amount of recieved waste, 381 379 ton in 1997, to represent the amount per functional unit.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Data type: Economical information Method: Amount used 5 140 l. Literature: The environmental report of 1997 for GRAAB. Notes: Ammonia solution (25%) Used to reduce NOx emissions.	Input	Refined resource	Ammonia	4.43			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Amount used 46 099 litres. Literature: The environmental report of 1997 for GRAAB. Notes: HCL (30%)	Input	Refined resource	HCl	0.12			l	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Total amount used 2 950 kg. Literature: The environmental report of 1997 for GRAAB. Notes:	Input	Refined resource	Levoxin/Hydrazin	0.008			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Amount used 2 710 000 kg. Literature: The environmental report of 1997 for GRAAB. Notes: Used in the water treatment.	Input	Refined resource	Lime	7.11			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Totally 23 021 litres used. Literature: The environmental report of 1997 for GRAAB. Notes: NaOH (100%)	Input	Refined resource	NaOH	0.03			l	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Amount used 527 kg. Literature: The environmental report of 1997 for GRAAB. Notes: Flockingsubstance Used in the water treatment.	Input	Refined resource	Polymers	0.0014			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Amount used 256 000 kg. Literature: The environmental report of 1997 for GRAAB. Notes: Used in the water treatment.	Input	Refined resource	Slaked lime	0.67			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Amount used 25 595 kg. Literature: The environmental report of 1997 for GRAAB. Notes: Precipitation substance Used in the water treatment.	Input	Refined resource	TMT 15	0.067			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Total amount used 1 400 kg. Literature: The environmental report of 1997 for GRAAB. Notes: Swedish name	Input	Refined resource	Trinatriumfosfat	0.0037			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: The trucks are weighted when delivering waste to determin the amount. Total amount recieved	Input	Refined resource	Waste	1			tonne	Technosphere	Sweden

about 381 379 tonnes. Literature: The environmental report of 1997 for GRAAB.									
Date concieved: 1997 Data type: Monitored data, continuous Method: Opacitet (Opastop GP-1000H) and Durag D-R300-40 Totally 6 800 kg emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Ashes	17.83			g	Air	Sweden
Date concieved: 1997 Data type: Single sample Method: Analyse performed by VBB VIAK Total emission 6 kg. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Cd	0.0157			g	Air	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: Samples are taken automatically, proportional to the flow. The total amount emitted is calculated based on the geometrical average over the months. Totally 1 120 g emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Cd	2.93			mg	River	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: Samples are taken automatically, proportional to the flow. The total amount emitted is calculated based on the geometrical average over the months. Totally 1 954 078 160 g emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Cl	5123.71			g	River	Sweden
Date concieved: 1997 Data type: Monitored data, continuous Method: Continously registration by measurement method IR (MEKOS-100) Totally 85 kg emitted. Literature: The environmental report of 1997 for GRAAB	Output	Emission	CO	0.22			g	Air	Sweden
Date concieved: 1997 Data type: Monitored data, continuous Method: Continously registration by measurement method IR (MEKOS-100) Totally 411 358 tonnes emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	CO2	1078.6			kg	Air	Sweden
Date concieved: 1997 Data type: Single sample Method: Analyse performed by VBB VIAK. Totally 7 kg emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Cr	0.018			g	Air	Sweden
Date concieved: 1997 Data type: Single sample Method: Analyse performed by VBB VIAK. Totally 28 kg emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Cu	0.073			g	Air	Sweden
Date concieved: 1997 Data type: Single sample Method: Analyse performed by VBB VIAK. Total amount emitted 10.0 mg. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Dioxine	0.0000			mg	River	Sweden
Date concieved: 1997 Data type: Single sample Method: Analyse performed by VBB VIAK. Total amount emitted 1,43 mg. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Dioxine	0.0000			mg	Air	Sweden

Date concieved: 1997 Data type: Monitored data, continuous Method: Continosly registration by measurement method IR (MEKOS-100) Total amount emitted 44 000 kg. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	HCl	115.37			g	Air	Sweden
Date concieved: 1997 Data type: Single sample Method: Analyse performed by VBB VIAK Totally 19 kg emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Hg	0.0498			g	Air	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: Samples are taken automatically, proportional to the flow. The total amount emitted is calculated based on the geometrical average over the months. Totally 30 g emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Hg	0.0787			mg	River	Sweden
Date concieved: 1997 Data type: Single sample Method: Analyse performed by VBB VIAK Totally 6 kg emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Ni	0.0157			g	Air	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: Samples are taken automatically, proportional to the flow. The total amount emitted is calculated based on the geometrical average over the months. Totally 1 000 g emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Ni	2.6221			mg	River	Sweden
Date concieved: 1997 Data type: Monitored data, continuous Method: Continosly registration by measurement method IR (MEKOS-100) Totally 206 000 kg emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	NOx	540.14			g	Air	Sweden
Date concieved: 1997 Data type: Single sample Method: Analyse performed by VBB VIAK Totally 185 kg emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Pb	0.485			g	Air	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: Samples are taken automatically, proportional to the flow. The total amount emitted is calculated based on the geometrical average over the months. Totally 720 g emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Pb	1.8879			mg	River	Sweden
Date concieved: 1997 Data type: Monitored data, continuous Method: Continosly registration by measurement method IR (MEKOS-100) Totally 431 000 kg emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	SO2	1130.1			g	Air	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: Samples are taken automatically, proportional to the flow. The total amount emitted is calculated based on the geometrical average over the months. Totally 52	Output	Emission	SO4	136.35			g	River	Sweden

002 080 g emitted. Literature: The environmental report of 1997 for GRAAB.									
Date concieved: 1997 Data type: Monitored data, discrete Method: Samples are taken automatically, proportional to the flow. The total amount emitted is calculated based on the geometrical average over the months. Totally 2 200 088 g emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Susp solids	5.7688			g	River	Sweden
Date concieved: 1997 Data type: Single sample Method: Analyse performed by VBB VIAK. Total emission 456 kg. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Zn	1.19			g	Air	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: Samples are taken automatically, proportional to the flow. The total amount emitted is calculated based on the geometrical average over the months. Totally 7 600 g emitted. Literature: The environmental report of 1997 for GRAAB.	Output	Emission	Zn	19.93			mg	River	Sweden
Date concieved: 1997 Data type: Economical information Method: Total amount extracted 130 000 kWh. Literature: The environmental report of 1997 for GRAAB.	Output	Product	Electricity	0.34			kWh	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Totally 1 040 000 kWh extracted. Literature: The environmental report of 1997 for GRAAB. Notes: Distributed to Göteborgs district heating.	Output	Product	Thermal energy	2.7269			kWh	Technosphere	Sweden
Date concieved: 1997 Literature: The environmental report of 1997 for GRAAB. Notes: Total amount originated from the combustion process 92 759 tonnes.	Output	Residue	Waste	243.2			kg	Technosphere	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology --- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally the result is a part of Reci's ISO 14000 certification, which acts as a guarantee to the customers. The quality of the inquiry is set due to the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emission released from combustion of scrap, delivered to Sävenäs from Reci Industri.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden

Applicability	The data are specific for combustion of scrap from Reci Industri.
About Data	Scrap Scrap is delivered to the facility by truck from Reci Göteborg. The scrap is a waste product derived when filtering the waste-oil, it often varies much in its contents, everything from cotton waste to plastic caps. The thing they have in common is that they are smudged with oil and thereby suitable for combustion. Totally about 160 tonnes are delivered (150 from Reci Göteborg and 10 from Reci Halmstad). Calculations · As the content is unknown it is impossible to say what emissions and resource use should be loaded upon the combustion of scrap. The energy content is also hard to predict as the scrap may contain incombustible particles as well. Therefore no calculations have been done beside the allocation approach, as they would be more of assumptions and guesses then representing any actual results. Mass-balance · When calculating on the in and outflow represented in the environmental report no balance of masses is achieved. This is supposed to be caused by the water contents in the delivered wastes. No measurement has been made on water vapour emitted during combustion or the percentage of water in the delivered waste.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Combustion of waste oil

Administrative	
Finished	Y
Date Completed	2002-12-18
Copyright	
Availability	Public

Technical System	
Name	Combustion of waste oil
Functional Unit	84 kg oil
Functional Unit Explanation	84 kg was calculated as the yearly used amount at StoraEnso AB in Hyltebruk. The density of the oil is 0.892 kg/l.
Process Type	Unit operation
Site	Slite, Gotland
Sector	
Owner	Slite, Gotland
Technical system description	Discarding of oil used for lubrication is investigated in this data sheet. A tank with lubricating oil is replaced so the waste oil, in this case Mobil DTE PM 220, is discarded. The oil is used as fuel in the cement furnace. The furnace is 1400 degrees Celsius hot and has a 80 meter high chimney so the operation is estimated with combustion of gasoline. The energy content of gasoline is assumed to be 43.8 MJ/kg. Transports are excluded. The oil is filtered to lower the water content before it is burned, but this process is also excluded.

System Boundaries	
Nature Boundary	The lubricant comes from the technosphere. All emissions are air emissions.
Time Boundary	Data is collected autumn 2002. No changes in the procedure are planned for the nearest future.

Geographical Boundary	The combustion takes place at Slite, Gotland.
Other Boundaries	Transports are excluded. The oil is filtered to lower the water content before it is burned, but this process is also excluded.
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002-09-01 - 2002-12-31
Data Type	Estimated from similarity
Represents	Combustion of gasoline
Method	Personal communication with Camilla Boström at Reci Industri.
Literature Reference	LCI database SPINE@CPM
Notes	none

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: In this case Mobil DTE PM 220.	Input	Refine resource	Oil	84			kg	Technosphere	
	Output	Co-product	Co-produced energy	3679			MJ	Technosphere	
	Output	Emission	CO	1.35			kg	Air	
	Output	Emission	CO2	276			kg	Air	
	Output	Emission	NOx	0.43			kg	Air	
	Output	Emission	Particles	0.0039			kg	Air	
	Output	Emission	SO2	0.019			kg	Air	
	Output	Emission	VOC	0.423			kg	Air	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. -------------------- Data documented by Sandra Häggström, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-03-21
Intended User	Product developer at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The purpose for our study is to compare a coated roller bearing to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is lubricated with a circulating oil system in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	Applicable for mineral oils in general if the accuracy of the emissions does not need to be more precise.
About Data	The data is collected from personal communication with Annika Lorin at SAKAB.
Notes	

SPINE LCI dataset: Combustion of waste to generate heat and electricity

Administrative	
Finished	Y
Date Completed	1996-03-01
Copyright	
Availability	Public

Technical System	
Name	Combustion of waste to generate heat and electricity
Functional Unit	MWh
Functional Unit Explanation	1 MWh extracted heat and energy from the combusted waste. 93,4% heat used for district heating and 6,62% electricity delivered to the power mains. This amount of energy is extracted from 0,38998 ton combusted waste
Process Type	Gate to gate
Site	GRAAB, Sävenäs Box 95 40121 Göteborg Sweden
Sector	Grid electricity and district heat
Owner	GRAAB, Sävenäs Box 95 40121 Göteborg Sweden
Technical system description	The company has a combustion plant, which extracts energy, in form of electricity and district heating, from combustible waste. There is also a sorting plant and a recycling station situated at the site. The thermal energy plant, which combusts waste, in Sävenäs was taken in operation 1972, and today approx. 400 000 ton waste is combusted each year. The combustion resolves in approx. 950 GWh heat and 106 GWh electricity. The waste combusted at the plant is transported to the emptying hall by lorry and emptied into the waste bunker. Some of the waste (mostly coarse building-, demolition- and industrial waste´) is taken to the sorting plant to be sorted and reprocessed before it is transported by a belt conveyor to the waste bunker at the combustion plant. There is also a recycling station at the plant, where households are able to leave recycleble waste duty free. The waste handled in the station is combustible waste, non combustible waste, scrap, hazardous waste, paper, batteries, fluorescent lamp, corrugated cardboard, scrap-elecronics, glass, clothes etc. The ammounts that are handeled in the combustion plant are only the three first categories. A manually manuvered crane feeds the oven with waste via a refill funnel and a refill shaft out on the grate. The waste is feed to the grate during the combustion and the burnt out slag falls down into a trough where the slag is put out. The put out slag is transported out to the slag bunker, where it cools before dumped. Primary air to the combustion is taken from the waste bunker. The air is added to the process under the grate so that the air cools when it passes through the grate blocks. The secondary air constitutes air from the slagg bunker but also recirculated smoke gas. The recirculation increases the surplus of air and therefore also the emission mainly of NOx. To further reduce the emission of NOx an ammonia solution (25% ammonia) is added on the fireplace. Air is added to the walls of the furnace to keep the walls cool and prevent slag from getting stuck on them. This air is taken from the oven house. The fume gas that is made during the combustion passes through an exhaust boiler, a feed water economizer and an electric filter, which is the first step in cleaning the fume gas. After this the gas passes a wet and condensing fume gas cleaner, where a considerable part of the extraction of energy is done. In the smoke gas cleaning plant the gas passes the different steps in the following order: Fume gas economizer, in which the gas emits its heat to the hot water system Quench, which cools the gas with circulating flush water. Washing reactor, in which the gas is cleansed when water is flushed over the gas A condensing reactor, that cleans the gas by condensation. The contaminations and moisture is liquidized. The gained heat is used as a source of heat to the absorption heat pumps. A surplus of water arises in this recirculating system, because of the condensation. This surplus is led to the sewage treatment works and is cleansed. Smoke gas reheater Fume gas fan, whith silencer Smoke stack. From the combustion of waste, heat is produced through a back-pressure condenser and

electricity is produced by a steam turbine.

Technical equipment in the plant

-Combustion

Waste bunker
Usable space: approx. 22 000 m3
11 000 ton waste
14 pcs bunker gate
1 pcs shears, von Rol (1972)

Waste overhead crane
2 pcs overhead crane from Svenska Lyft AB (1084)
2 pcs universal plier bucket (8 m3) from: lifting crane 14 ton

Combustion ovens
Oven 1.
Supplier: von Roll/Kvaerner Enviro Power AB (1994)
Power: 15 ton waste per hour
Thermal heating value: 2,6 MWh per 1 ton waste
Driven by 3-steps plane grate:
The dosage grate is of type length grate
The main grate is of type crosswise grate
Smoke gas recirculation, where 15% of the flow is brought back as secundary combustion air.

Oven 4 and 5
Supplier: von Roll/Kvaerner Enviro Power AB (1972)
Power: 22 ton waste per hour
Thermal heating value: 2,9 MWh per 1 ton waste
Driven by inclined grate, whith puscher
Smoke gas recirculation, where 15% of the flow is brought back as secundary combustion air.

Exhaus steam boiler

Boiler 1.
Supplier: von Roll/Kvaerner Enviro Power AB (1972)
Operating peressure: 20 bar dry, hand steam (212 deg C). Maximum continuous load: 55 ton steam/hour.
Feed watereconomizer (Generator AB, 1982)
Capacity: 2,35 MW, 140-190 deg C
Total power: 33 MW

Boiler 4. and 5.
Supplier: von Roll/Kvaerner Enviro Power AB (1994)
Operating peressure: 40 bar overheated steam (400 deg C). Maximum continuous load: 73 ton steam/hour.
Total power: 58 MW

Cleaning and energy extraction
De-NOx plant
Primar step
Oven 1.
Smoke gas recycling
Supplier: von Roll AG
15% of the flow is brought back as secundary combustion air.
Reduction: approx. 25-30% NOx reduction

Oven 4. and 5.
Smoke gas recycling
Supplier: von Roll AG
25% of the flow is brought back as secundary combustion air.
Reduction: approx. 30% NOx reduction

Secundary step
Boiler 1.
SNCR
Supplier: von Roll AG
Reduction agent: 25% ammonia/water solution
Reduction: approx. 50% NOx reduction

Boiler 4. and 5.
SNCR
Supplier: von Roll AG
Reduction agent: 25% ammonia/water solution
Reduction: approx. 75% NOx reduction

Electric filter

Oven line 1.
Supplier: Svenska Fläkt AB (1972)
With extension (1975)

Reduction:
In-going dust content: approx.4 g / m3
Out-going dust content: approx. 40-80 mg / m3 for dry gas and 10% CO_2

Oven line 4. and 5.
Supplier: von Roll AG / Rothemuhle (1994)
Reduction:
In-going dust content: approx.1-2 g / m3
Out-going dust content: approx. < 25 mg / m3 for dry gas and 10% CO_2

Washing and condensation scrubbs
Manufacture: Götaverken Miljö AB (1988 and 1993)
Three smoke gas cleaning lines, one to each oven line

Cleaning of water (cleaning of process water to recipient)
Manufacture: Götaverken Miljö AB
Two lines with joint sand filter (1988)
Capacity: Maximum 43 m3 / h, normaly 24 m3 / h (8 m3 per hour and oven line)

Steam turbines and turbin condensors belonging to them
Manufacture: AEG Kanis (1988)
Capacity: 14 MW
Turbine condensor
Normal heat production: TG 30,6 MW = 55,5 ton steam
Maximum heat production: 55,2MW = 98,0 ton steam
Production of heat at bypass (the turbine is shut down):
Normal heat production91,0MW = 142,0 ton steam
Maximum heat production: 100,0 MW = 156,0 ton steam

Manufacture: AEG STAL (1995)
Capacity: 35 MW
Turbine condensor
When the turbine is in operation: Condenser power at full load = 73 MW
At by-pass (only heat production): Maximum condenser power = 170 MW

Absorption heat pumps
Manufacture: 4 pcs Sanyo Japan (1988)
Nominal cooling power 3,8 MW each
Maximum cooling power 4,8 MW each

Manufacture: Ahlström (1995)
Nominal cooling power 12,5 MW

Smoke gas economizer
Manufacture: Generator AB (1988)
Exhaustion bioler (hot water eco)
Power: 3,1 MW each

Steam-dump condenser
Manufacture: Götaverken / Martin Larsson (1988)
Steam-dump condenser (20 bar)
Nominal maximum power:141 ton, 90,3 MW
A new steam dump condenser was taken into operation when the new steam system was taken into operation.

Slag / Rest products
Slag bunker: usable volume 1600 m3
Scoop: approx. 3,0 m3 two jaws scoop, lifting capacity 7,3 ton
Slag is feed out of oven 1,2 and 3, through the trough where the slag is put out, by slag chain. From oven 4 and 5 through the slag pucher by the belt conveyor.

Flying ashes/ sludge
Flying ashes are feed through the flying ashes transporter to the two flying ashes silos, each of the volume 85 m3.
From the silos the ashes goes to a moisteriser, where the ashes are mixed with sludge from the water cleansing. The mixing is done intermittently in the daytime.

Smoke stack
The smoke stack consists of 3 separate corten steel pipes, of the hight of 126 m. The duct of the smoke stack has a diameter of 1,6 m.

Ammonia recycling
Supplier: von Roll AG
Ammonia surplus in the processing water is recyced and is added afresh to the SNCR-plant. The plant has a capacity of 2x22 m3 processing water per hour.

Special oven
Manufacture: Bruun & Sörensen
Capacity: 200 kg / h
Support combustion is done with oil-burner
Approx. 150 ton special waste (biological hazardous waste and dead small animals) is combusted per year.
The smoke gas is lead to optional combustion oven for cleaning and extraction of energy.

	Vehicle weighing-machine Manufacture: Fintab 4 pcs with micro computor based system for automatic weighing and registration of waste, slag, scrap etc. Sorting plant Machine equipment supplied by Svenska Fläkt AB (1984) Capacity: 80 000 ton industrial waste per year. Function: A cleansed and reprocessed waste fraction is maintained from industrial waste by means of picking crane, magnet separater, hammer mill, drum sieving sieve, waste shears and so on. Waste bunker: capacity: 1600 m3 (400 ton) Scoop capacity: 8 m3

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	The amount of the hazardous waste is not specified, but the company states that it consists of lubricating oil, waste oil and other similar rest products from the processes. The waste is taken care of by a hazardous waste disposal company.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified
Represents	Combustion of gasoline
Method	Study the Environmental report The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1995. Analyses of the emissions are made according to Swedish standards developed by the Swedish Environmental Protection Agency.
Literature Reference	LCI database SPINE@CPM
Notes	none

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1995 Data type: Unspecified Notes: Consist of 25% ammonia and the rest H2O	Input	Refined resource	Ammonia	1.505070808			kg	Technosphere	
Notes: 25% Caustic soda and the rest is water. Used for cleansing of smoke gas.	Input	Refined resource	Caustic soda	0.00678883			l	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: 45% Caustic soda the rest H2O. Used when treating the feeding water.	Input	Refined resource	Caustic soda	0.021241779			l	Technosphere	
Date concieved: 1995 Data type: Monitored data, continuous Method: The amounts of waste delivered to the site is weighed at arrival. Notes: The total amount in the table was combusted in the combustion ovens and the special oven during 1995. The combustible waste consists of Reloaded waste 37,1 % Stored waste fuel 8,62 % Sorted waste 8,70 % Waste directly to combustion 45,5 % Special	Input	Refined resource	Combustible waste	0.389976655			tonne	Technosphere	

waste 0,0342 % Dead small animals 0,00493%									
Date concieved: 1995 Data type: Unspecified Notes: (Polymere) Used for cleaning the smoke gas	Input	Refined resource	Flocculo agents	0.00043124			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: 96,3% Eo4xls, fuel oil with extra low S content, used in the waste combustion ovens. 3,69% Eo 1, fuel oil with maximum 1% S, used in the special oven.	Input	Refined resource	Fuel oil	0.001795411			m3	Technosphere	
Notes: 30% HCl. Used for nitrogen reduction (30,0%) and in the treatment of the feeding water (70,0%).	Input	Refined resource	Hydrochloric acid	0.049154972			l	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: (Hydrazin) Used in the treatment of the feeding water.	Input	Refined resource	Levoxin	0.002743285			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used for cleaning the smoke gas.	Input	Refined resource	Limestone	2.032379303			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: TMT 15 Used for cleaning the smoke gas	Input	Refined resource	Precipitation agent	0.023467363			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used for cleaning the smoke gas	Input	Refined resource	Slaked lime	0.363992302			kg	Technosphere	
Notes: Used in the treatment of the feeding water	Input	Refined resource	Trisodium phosphate	0.001254226			kg	Technosphere	
Date concieved: 1995 Data type: Estimated Method: The amount in the table is based on the measurements done at the periodic controll, and the fact that the annual time of operation 20 328 hours, of which 304 hours consist of bypass time. The contamination contents in the air during bypass is based on previous measurement. The metal contents in the dust are assumed to be the same when the smoke gas condensing plant is in operation as when it is not.	Output	Emission	As	0.00213485221			g	Air	
Date concieved: 1995 Data type: Estimated Method: The amount in the table is based on the measurements done at the periodic controll, and the fact that the annual time of operation 20 328 hours, of which 304 hours consist of bypass time. The contamination contents in the air during bypass is based on previous measurement. The metal contents in the dust are assumed to be the same when the smoke gas condensing plant is in operation as when it is not.	Output	Emission	Be	0.00010674261			g	Air	
Date concieved: 1995 Data type: Monitored data, discrete Method: Every day spiecimens proportionell to the flow are taken on the cleansed outgoing processing water. The day-spiecimens are added together to a month spiecimen, which is analysed by an accredited laboratory. The annual amount	Output	Emission	Ca	0.000000640456			kg	Water	

of emissions is based on these analyses (arithmetic average) and the monthly flow of the processing water. The specimens are analysed according to Swedish standard developed by the Swedish Environmental Protection Agency. No method number is specified in the environmental report.									
Date concieved: 1995 Data type: Estimated Method: The amount in the table is based on the measurements done at the periodic controll, and the fact that the annual time of operation 20 328 hours, of which 304 hours consist of bypass time. The contamination contents in the air during bypass is based on previous measurement. The metal contents in the dust are assumed to be the same when the smoke gas condensing plant is in operation as when it is not.	Output	Emission	Cd	0.00320227831			g	Air	
Date concieved: 1995 Data type: Monitored data, discrete Method: The contamination content in the air is continuously registrated (every 10 secunds) and compiled into month averages. Knowing the time of operation and the smoke gas flow, an average (arithmetic average) for the whole year can be calculated. This is the amount shown in the table. The measuring instrument was avalible 99,8% of the time at oven line 1, 99,5% at line 4 and 99,6% at 5.	Output	Emission	Chlore hydrogen	0.0000245508			tonne	Air	
Date concieved: 1995 Data type: Monitored data, discrete Method: Every day spiecimens proportionell to the flow are taken on the cleansed outgoing processing water. The day-spiecimens are added together to a month spiecimen, which is analysed by an accredited laboratory. The annual amount of emissions is based on these analyses (arithmetic average) and the monthly flow of the processing water. The specimens are analysed according to Swedish standard developed by the Swedish Environmental Protection Agency. No method number is specified in the environmental report.	Output	Emission	Co	0.000000779221			kg	Water	
Date concieved: 1995 Data type: Monitored data, discrete Method: The contamination content in the air is continuously registrated (every 10 secunds) and compiled into month averages. Knowing the time of operation and the smoke gas flow, an average (arithmetic average) for the whole year can be calculated. This is the amount shown in the table. The measuring instrument was avalible 99,9%	Output	Emission	CO	0.000100338			tonne	Air	

of the time at oven line 1, 99,8% at line 4 and 99,4% at 5.									
Date concieved: 1995 Data type: Monitored data, discrete Method: Every day spiecimens proportionell to the flow are taken on the cleansed outgoing processing water. The day-spiecimens are added together to a month spiecimen, which is analysed by an accredited laboratory. The annual amount of emissions is based on these analyses (arithmetic average) and the monthly flow of the processing water. The specimens are analysed according to Swedish standard developed by the Swedish Environmental Protection Agency. No method number is specified in the environmental report.	Output	Emission	Cr	0.00000138765			kg	Water	
Date concieved: 1995 Data type: Estimated Method: The amount in the table is based on the measurements done at the periodic controll, and the fact that the annual time of operation 20 328 hours, of which 304 hours consist of bypass time. The contamination contents in the air during bypass is based on previous measurement. The metal contents in the dust are assumed to be the same when the smoke gas condensing plant is in operation as when it is not.	Output	Emission	Cr	0.0213485221			g	Air	
Date concieved: 1995 Data type: Estimated Method: The amount in the table is based on the measurements done at the periodic controll, and the fact that the annual time of operation 20 328 hours, of which 304 hours consist of bypass time. The contamination contents in the air during bypass is based on previous measurement. The metal contents in the dust are assumed to be the same when the smoke gas condensing plant is in operation as when it is not.	Output	Emission	Cu	0.00960683494			g	Air	
Date concieved: 1995 Data type: Monitored data, discrete Method: The contamination content in the air is continuously registrated (every 10 secunds) and compiled into month averages. Knowing the time of operation and the smoke gas flow, an average (arithmetic average) for the whole year can be calculated. This is the amount shown in the table. The final value is taken from the environmental report and then devided with the annual production.	Output	Emission	Dust	0.0000057641			tonne	Air	
Date concieved: 1995 Data type: Monitored data, discrete Method: Every day spiecimens proportionell to the flow are taken on the cleansed outgoing processing water. The day-	Output	Emission	Hg	0.0000000853941			kg	Water	

spiecimens are added together to a month spiecimen, which is analysed by an accredited laboratory. The annual amount of emissions is based on these analyses (arithmetic average) and the monthly flow of the processing water. The specimens are analysed according to Swedish standard developed by the Swedish Environmental Protection Agency. No method number is specified in the environmental report.									
Date concieved: 1995 Data type: Estimated Method: The amount in the table is based on the measurements done at the periodic controll. Measurements were done during a time period (which is not specified further) and knowing the annual time of operation (20 328 hours, of which 304 hours consist of bypass time) the annual amount can be calculated. The contamination contents in the air during bypass is based on previous measurement. The metal contents in the dust are assumed to be the same when the smoke gas condensing plant is in operation as when it is not.	Output	Emission	Hg	0.0224159482			g	Air	
Date concieved: 1995 Data type: Monitored data, discrete Method: Every day spiecimens proportionell to the flow are taken on the cleansed outgoing processing water. The day-spiecimens are added together to a month spiecimen, which is analysed by an accredited laboratory. The annual amount of emissions is based on these analyses (arithmetic average) and the monthly flow of the processing water. The specimens are analysed according to Swedish standard developed by the Swedish Environmental Protection Agency. No method number is specified in the environmental report.	Output	Emission	Ni	0.000000779221			kg	Water	
Date concieved: 1995 Data type: Estimated Method: The amount in the table is based on the measurements done at the periodic controll, and the fact that the annual time of operation 20 328 hours, of which 304 hours consist of bypass time. The contamination contents in the air during bypass is based on previous measurement. The metal contents in the dust are assumed to be the same when the smoke gas condensing plant is in operation as when it is not.	Output	Emission	Ni	0.00960683494			g	Air	
Date concieved: 1995 Data type: Monitored data, discrete Method: The contamination content in the air is continuously registrated (every 10 secunds) and compiled into month averages. Knowing the time of operation and the	Output	Emission	NOx	0.000213485			tonne	Air	

smoke gas flow, an average (arithmetic average) for the whole year can be calculated. This is the amount shown in the table. The measuring instrument was avalible 99,8% of the time at oven line 1, 99,5% at line 4 and 99,6% at 5.									
Date concieved: 1995 Data type: Monitored data, discrete Method: Every day spiecimens proportionell to the flow are taken on the cleansed outgoing processing water. The day-spiecimens are added together to a month spiecimen, which is analysed by an accredited laboratory. The annual amount of emissions is based on these analyses (arithmetic average) and the monthly flow of the processing water. The specimens are analysed according to Swedish standard developed by the Swedish Environmental Protection Agency. No method number is specified in the environmental report.	Output	Emission	Pb	0.00000072585			kg	Water	
Date concieved: 1995 Data type: Estimated Method: The amount in the table is based on the measurements done at the periodic controll, and the fact that the annual time of operation 20 328 hours, of which 304 hours consist of bypass time. The contamination contents in the air during bypass is based on previous measurement. The metal contents in the dust are assumed to be the same when the smoke gas condensing plant is in operation as when it is not.	Output	Emission	Pb	0.0565735836			g	Air	
Date concieved: 1995 Data type: Monitored data, discrete Method: The contamination content in the air is continuously registrated (every 10 secunds) and compiled into month averages. Knowing the time of operation and the smoke gas flow, an average (arithmetic average) for the whole year can be calculated. This is the amount shown in the table. The measuring instrument was avalible 99,8% of the time at oven line 1, 99,5% at line 4 and 99,6% at 5.	Output	Emission	SO2	0.000437645			tonne	Air	
Date concieved: 1995 Data type: Monitored data, discrete Method: Every day spiecimens proportionell to the flow are taken on the cleansed outgoing processing water. The day-spiecimens are added together to a month spiecimen, which is analysed by an accredited laboratory. The annual amount of emissions is based on these analyses (arithmetic average) and the monthly flow of the processing water. The specimens are analysed according to Swedish standard	Output	Emission	Zn	0.00000462196			kg	Water	

developed by the Swedish Environmental Protection Agency. No method number is specified in the environmental report.									
Date concieved: 1995 Data type: Estimated Method: The amount in the table is based on the measurements done at the periodic controll, and the fact that the annual time of operation 20 328 hours, of which 304 hours consist of bypass time. The contamination contents in the air during bypass is based on previous measurement. The metal contents in the dust are assumed to be the same when the smoke gas condensing plant is in operation as when it is not.	Output	Emission	Zn	0.19747382938			g	Air	
Date concieved: 1995 Data type: Economical information Notes: The amount in the table shows the amount thermal energy, which is sold and used as district heating.	Output	Product	District heating	0.934			MWh	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: The amount in the table shows the amount of electricity delivered to the power mains.	Output	Product	Electricity	0.0662			MWh	Technosphere	
Date concieved: 1995 Notes: Consists of flying ashes from the electric filter, and sludge from the water cleaning process. Before transportaion and dumping the tvo different substanses are mixed into so called ''Bambergkaka''. the waste is dumped at Tagene. The contamination contents in the slag Substanse Oven line 1. Oven line 2. Oven line 3. Unit Hg 16 16 19 (mg/kg DS) Cd 150 120 160 (mg/kg DS) Pb 4400 2900 4900 (mg/kg DS) Zn 19000 14000 19000 (mg/kg DS) As 250 200 160 (mg/kg DS) Be 1,5 0,9 1,2 (mg/kg DS) Cu 1000 830 960 (mg/kg DS) Cr 190 140 210 (mg/kg DS) Ni 67 49 51 (mg/kg DS) Dry Substanse (DS) 80,4 64,1 78,2 (%)	Output	Residue	Ashes and sludge	0.080613087			tonne	Technosphere	
Notes: Consist of scrap and other non combustible waste that has been sorted out at the sorting plant. The rest products are transported to GRAAB plant at Tagene to be dumped or recycled.	Output	Residue	Non combustible waste	0.00415976			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Consists of bottom ashes and slag from the combustion process. The restproducts are dumped at Tagene. The contamination contents in the slag Substanse Oven line 1. Oven line 2. Oven line 3. Unit Hg 0,22 0,05 0,04 (mg/kg DS) Cd <1,0 <1,0 <1,0 (mg/kg DS) Pb 700 440 520 (mg/kg DS) Zn 2700 1700 1400 (mg/kg DS) As 89 4,2 65 (mg/kg DS) Be 0,92 1,0 0,71 (mg/kg DS) Cu 3000 910 1600 (mg/kg DS) Cr 120 75 120 (mg/kg DS) Ni 58 79 77 (mg/kg DS) Dry Substanse	Output	Residue	Slag	0.080613087			tonne	Technosphere	

(DS) 74,9 79,7 83,5 (%)									

About Inventory	
Publication	The environmental report for GRAAB, Sävenäs from 1995, The Board of County in Göteborg and Bohus The Department of Environment -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden.
Practitioner	Lundgren Christer - GRAAB Box 95 40121 Göteborg Sweden.
Reviewer	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden
Applicability	
About Data	The flow of waste into and out of the system does not quite add up. In the table only show the amounts of waste that is combusted, and the amount of non combustible waste that has been sorted out at the sorting plant. The actual fact is that more flows of waste are involved (among others that from the recycling station). All the information about the flows of waste from the environmental report is shown below: The amount of treated waste Reloaded waste coming from the six different staions situated in Högsbo, Kungälv, Lerum, Mölndal, Kungsbacka and Öckerö: 142806 ton Waste left at the recycling station situated at Sävenäs: Combustible 3202 ton Non combustible 1046 ton Scrap 507 ton Industrial waste sorted at the sorting plant: Non combustible waste 3897 ton Fuel fraction 31775 ton The amount of combusted waste Waste combusted in the waste combustion ovens Reloaded waste 135500 ton Stoared waste fuel 31500 ton Sorted waste 31800 ton Waste directly combusted 166400 ton Waste combusted in the special oven Special waste 125 ton Separate cremations 18 ton The waste from the combustion plant (non combustible) Non combustible waste from the sorting plant 3897 ton Waste from the combustion ovens Slag 75521 ton Flying ashes and sludge 14563 ton Hazardous waste (no amount specified) In the table on the sold energy (the product) is specified, all though this is not the only energy produced. Some of the energy extracted from the waste is used in the process and is therefore not a net product.

	The total energy flow can be seen below: Heat used for district heating (sold product) 874 816 MWh Electricity to the power mains (sold product) 62 017 MWh Internal process consumption (used at Sävenäs) 55 236 MWh Consumption of heat (used in the sorting plant) 1 824 MWh Internal consumption of heat (hot tap water used at Sävenäs) 11 750 MWh Internal consumption of electricity (used at Sävenäs) 43 601 MWh Waste heat (waste when restarting the plant) 8 099 MWh ____ Total energy extraction at the plant + 1 057 313 MWh
Notes	

SPINE LCI dataset: Composting of solid municipal waste

Administrative	
Finished	Y
Date Completed	2002-08-14
Copyright	McDougall F. et al, Integrated Solid Waste Management
Availability	Public

Technical System	
Name	Composting of solid municipal waste
Functional Unit	1 tonne of biowaste
Functional Unit Explanation	1 tonne of biowaste contains 15 weight-% non-recyclable paper and 85 weight-% organic waste (Average values based on O.E.C.D, Environmental Data Compendium, Organisation for Economic Cooperation and Development. Paris, 1997)
Process Type	Gate to gate
Site	Europe
Sector	Waste treatment
Owner	Europe
Technical system description	Composing can be used to treat both organic and non-recyclable paper fractions of solid waste. A compost is the simplest form of biological aerobic treatment. It require regular turning (aeration) to transform organic material to a rich and useful compost. In this system a Windrows process is used. Inflow to the composting process is pre-sorted biowaste (non-recyclable paper and organic waste). Outflows are compost (compost markets are e.g.soil conditioner or improver, soil fertilizer and mulch) and compost residue. Compost residue is defined as residues from biological treatment that cannot be marketed as products due to contamination levels (stone, plastic, metals or textiles) or lack of suitable markets. - Air emissions from the composting: In aerobic treatment processing organic material is broken down directly to carbon dioxide and water. The amount of air emissions per tonne of process input will depend on the moisture content of the incoming material. An average moisture content of 50% can be assumed. (ORCA 1992a). Emissions of volatile compounds as well as CO2 from composting are air emissions in this activity. - Water emissions from the composting: The aqueous effluents reported for biological treatment vary widely in both amounts and composition, depending on both the process used and the feedstock. In composting, considerable evaporation will take place during the process. Any run-off collected is often sprayed back onto the composition material to maintain sufficiently high moisture contents. Waste paper included in the feedstock will absorb much water and therefore little or no leachate is produced. Composting involves a net consumption of energy, consuming process energy and not producing any energy in a usable form. Mass loss due to evaporation and biodegradation of the organic fraction of final vary between 30-60%. Due to the wide range of different composting processes available mass

	loss vary. 50% is a generic value used here. (McDougall, 2001) References: ORCA, Information on Composting and Anaerobic Digestion, ORCA Technical Publication NO.1, Organic Reclamation and Composting Association, Brussels. McDougall F. et al, Integrated Waste Management - a Life Cycle Inventory, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001

System Boundaries

Nature Boundary	A composting plant require a considerable area of land but due to lack of data this is not included in the system. The energy consumption and the emissions to air and water are accounted for. Reported emissions were the ones measured in the study. The fact that emissions on different geographical places can have different effects on the environment has not been accounted for.
Time Boundary	Data are from studies made 1992-2001.
Geographical Boundary	The system is aimed to represent a composting plant in Europe.
Other Boundaries	Subsystems not considered are transports from sorting station to composting area.
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Unspecified
Represents	Combustion of gasoline
Method	All LCI data are taken from the literature references, see specific for more details. Water emission has been estimated using information from Box composting process due to lack of information for the Windrow process. The following water emissions were calculated: COD, BOD, NH4+ and N-total. (Bergmann and Lentz, 1992) Emissions of volatile compounds from composting are presented as different substances and not one group. (De Baere, 1999)
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Bergmann and Lentz, Vorstudie zu einer Ökobilanz uber biologische Abfallbehandlungsverfahren, Report, Procter & Gamble GMbH, Schwalbach, Germany, 1992.
Notes	none

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Biowaste	1			tonne	Technosphere	
Method: The composting method Windrow was used here with a capacity of 13700 tonnes/year electrical and therefore the energy consumption will be 18 kWh/tonne (McDougall F. et al). Available data on the overall energy consumption for various methods of composting indicated that electrical energy needed for composting is between 18-50 kWh per input tonne. (The German Governement, 1993) (Bergmann and Lentz, 1992) Literature: German Government Report (1993), Energy consumption of various composting plants.	Input	Refined resource	Electricity	18			kWh	Technosphere	
Method: 283.6 g of alcohols/tonne biowaste composted Literature: De Baere, Anaerobic Digestion of Solid Waste: State of the Art, Proc, Second international Symposium on Anaerobic Digestion of Solid Waste, Barcelona, 15-18 June, 1999	Output	Emission	Alcohols	283.6			g	Air	

Method: 7.5 g of aldehydes/tonne biowaste Literature: De Baere, Anaerobic Digestion of Solid Waste: State of the Art, Proc, Second international Symposium on Anaerobic Digestion of Solid Waste, Barcelona, 15-18 June, 1999	Output	Emission	Aldehydes	7.5			g	Air	
Method: Water emission has been estimated using information from Box composting process due to lack of information for the Windrow process. Literature: Bergmann and Lentz (1992)	Output	Emission	BOD	0.113			kg	Water	
Method: 320 kg CO2 is formed per tonnes of wet organic material. (McDougall, 2001)	Output	Emission	CO2	265.2			kg	Air	
Method: Water emission has been estimated using information from Box composting process due to lack of information for the Windrow process. Literature: Bergmann and Lentz (1992)	Output	Emission	COD	0.1899			kg	Water	
Method: 52.7 g Esters/tonne biowaste Literature: De Baere, Anaerobic Digestion of Solid Waste: State of the Art, Proc, Second international Symposium on Anaerobic Digestion of Solid Waste, Barcelona, 15-18 June, 1999	Output	Emission	Esters	52.7			g	Air	
Method: 2.6 g Ethers/tonne biowaste Literature: De Baere, Anaerobic Digestion of Solid Waste: State of the Art, Proc, Second international Symposium on Anaerobic Digestion of Solid Waste, Barcelona, 15-18 June, 1999	Output	Emission	Ethers	2.6			g	Air	
Method: 150.4 g Ketones/tonne biowaste Literature: De Baere, Anaerobic Digestion of Solid Waste: State of the Art, Proc, Second international Symposium on Anaerobic Digestion of Solid Waste, Barcelona, 15-18 June, 1999	Output	Emission	ketones	150.4			g	Air	
Method: Water emission has been estimated using information from Box composting process due to lack of information for the Windrow process. Literature: Bergmann and Lentz (1992)	Output	Emission	N total	0.15			g	Water	
Method: 158.9 g NH3/tonne biowaste Literature: De Baere, Anaerobic Digestion of Solid Waste: State of the Art, Proc, Second international Symposium on Anaerobic Digestion of Solid Waste, Barcelona, 15-18 June, 1999	Output	Emission	NH3	158.9			g	Air	
Method: Water emission has been estimated using information from Box composting process due to lack of information for the Windrow process. Literature: Bergmann and Lentz (1992)	Output	Emission	NH4+	24.7			g	Water	
Method: 9.3 g Organic sulphides/tonne biowaste Literature: De Baere, Anaerobic Digestion of Solid Waste: State of the Art, Proc, Second international Symposium on Anaerobic Digestion of Solid Waste, Barcelona, 15-18 June, 1999	Output	Emission	Organic sulphides	9.3			g	Air	
Method: 82.4 g Terpenes/tonne biowaste Literature: De Baere, Anaerobic Digestion of Solid Waste: State of the Art, Proc, Second international Symposium on Anaerobic Digestion of Solid Waste, Barcelona, 15-18 June, 1999	Output	Emission	Terpenes	82.4			g	Air	
Method: 2.5 % of the organic material and 2.5 % of the paper fractions are added to the residue beacuse it will not be biodegradable and will therefore not be included in the compost . 50% masslost gives 975*0.50= 487.5 kg of produced compost.	Output	Product	Compost	487.5			kg	Technosphere	
Method: 2.5% of the organic material and 2.5% of the paper fractions are not readily biodegradable and are therefore added to the residue.	Output	Residue	Slags and ash	25			kg	Technosphere	

About Inventory	
Publication	McDougall F. et al, Integrated Solid Waste Management - A Life Cycle Inventory, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Data documented by: Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, Industrial Environmental Informatics, Chalmers University of Technology Published in SPINE@CPM: 14 August 2002
Intended User	The original study this docume
General Purpose	Data about waste management systems are insufficient and more data are required by the industry.
Detailed Purpose	This documentation is based on a study about Integrated Solid Waste Management performed by Forbes McDougall et al at Procter & Gamble Technical Centres, 2001. The aims of that study was to introduce a LCI model for Integrated Waste Mangement and to provide data that support the concept of Integrated Waste Management as a sustainable method of managing solid waste. The purpose of the documentation of the system has been to make data for waste management available in this format for the industry.
Commissioner	
Practitioner	
Reviewer	
Applicability	This set of data could be applied to a composting plant and it gives a rough estimation of environmental loads of composting. For detailed study of composting more information is needed e.g. regarding feedstock, plant etc. A population of 500 000 in an urban area with a total amount of waste generated of 230 000 tonnes, gives around 28 500 tonnes of biowaste, 4275 tonnes (15 weight-%) of non-recyclable paper and 24 225 tonnes (85 weight-%) of organic material. (McDougall, 2001) In 2000, Renova in Sweden composted 20 000 tonnes of biowaste. For energy consumption the German Government have reported a typical energy consumption of 20 and 50 kWh (electrical energy) per input tonne for plants capable of processing 10 000 tonnes of biowaste per year. The energy consumption of the pre-treatment process will depend on the incoming waste used. Mixed waste, such as Municipal Solid Waste (MSW) will need more extensive sorting per tonne of input with associated energy requirements, than more narrowly defined feedstocks. The energy consumption of the biological treatment process itself will depend on the technology employed. The compost quality is determined by type of incoming waste, type of technology used and level of process control. The major variability occurs in the heavy metal content of the compost. A more mixed feedstock gives higher heavy metal content and a higher level of contamination may mean that no market for this material can be found. It should be remembered that a compost can contain small amounts of heavy metals. The heavy metal content in a compost produced by aerobic process is: Pb 513, Cd 5.5, Cr 71.4, Cu 274, Ni 44.9, Zn 1570, Hg 2.4 (in mg/kg dry wt) (McDougall, 2001) Windrows (static and dynamic) and enclosed vessels are two alternatives for composting. In this system a Windrows process is used, it require more space than enclosed vessels but otherwise they are similar. Windrow composting is also the most common technology used, being least capital intensive.
About Data	Data is based on a study performed by Procter & Gambler about Integrated Waste Management (F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001). Data are generally averages, giving an approximate measure of the environment burdens associated with the system. The descriptions of the activity is how it was understood by the person who made the documentation. To calculated CO2- emissions 320 kg per tonnes of wet organic material was used. Water emission has been estimated using information from Box composting process due to lack of information for the Windrow process. The following water emissions were calculated: COD, BOD, NH4+ and N-total. Assumptions have been made by McDougall et al. calculating the amount of residue and produced compost. 2.5 % of the treated organic material and 2.5 % of the treated paper fractions are added to the residue to account for material that are not readily biodegradable. 50 % mass lost gives 975* 0.50= 487.5 kg of produced compost

	Available data on the overall energy consumption for various methods of composting indicated that electrical energy needed for composting is between 18-50 kWh per input tonne. (German Government Report (1993), Energy consumption of various composting plants) (Bergmann and Lentz, Vorstudie zu einer Ökobilanz.., Report, Procter & Gamble GMbH, Schwalbach, Germany, 1992)
Notes	For further information about solid waste managment see: Flemström K., Brief overview of solid waste management, IMI-internal report. The report may be downloaded from: http://www.imi.chalmers.se

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SPINE LCI dataset: Connector assembly

Administrative	
Finished	Y
Date Completed	2000-03-09
Copyright	Ericsson
Availability	Official

Technical System	
Name	Connector assembly
Functional Unit	One gram of connector intended for mounting on PC-board
Functional Unit Explanation	The motivation for choosing this functional unit is: · Suitable unit to work with in an LCA of a private branch exchanges (a complicated telecom product) · Important component of the MD110 product system and many other electronic products. These facts are based on Ericsson technical specification of the component. Ericsson product number: RNV 256 201 Ericsson description: Fork connector Connector intended for mounting on PC-board. The plastic leg for mounting in the PC-board shall be of snap in type. The fork connector is angled fed or top fed. PCB thickness 1.6 mm. Suitable plug 390 290/X and 591 484/X. The loose ends of the contact spring shall be guided in slots in the housing. Material Frame: Polyester Contacts: Phosphorous bronze Surface treatment: Contact area: 1.27e-6 m Au on 1.27e-6 m Ni. Soldering tags: 2e-6 m SnPb on 1.27e-6 m Ni. Dimensions: Height: 16.4 mm, Length: 16.6 mm, Width: 14 mm, Terminal thickness: 0.9 mm Weight: 3 g
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of a connector intended for mounting on PC-board. Details on the production are not available. Note; This model is not based on information acquired from connector manufacturers. However, the electricity use for the production has been approximated using information describing other components; a loudspeaker and a push-button switch.

System Boundaries	
Nature Boundary	Emissions to air and water have been excluded due to lack of data.
Time Boundary	1998 The electricity use is based on information acquired in 1998 and they measured in 1998. The raw material use is based on the material declaration for the connector. The material declaration was developed in 1997.
Geographical Boundary	This model is intended to represent the assembly of connector in western Europe.
Other Boundaries	Delimitation's to the system is the final step in the making of the connector. The production of the subparts (e.g. frame, contacts and surface treatment) of the connector is not included in this model. The transportation of them to the factory is not included.
Allocations	Not relevant.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Electricity use for the production of ''Other'' component. See the model ''Other'' electronic components production for further details.
Method	Presented data for raw material input is based on a material declaration for a connector. Only amounts in product are presented, i.e. no waste is included. The electricity use has been approximated using the average electricity use for production of ''other'' components. See Specific QMetaData for Electricty for a further description. Details on the production of ''other'' components can be found in the model ''Other'' electronic components production
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Bergmann and Lentz, Vorstudie zu einer Ökobilanz uber biologische Abfallbehandlungsverfahren, Report, Procter & Gamble GMbH, Schwalbach, Germany, 1992.
Notes	none

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1998 Data type: Derived, unspecified Method: We had earlier made a material declaration of a fork connector by weighing it and looking at the materials stated in the product specification. The total weight was 3.01452 g for one connector. The gold content was 0.002667 g/g. Notes: No eventual material waste included.	Input	Refined resource	Au	0.0027			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: We had earlier made a material declaration of a fork connector by weighing it and looking at the materials stated in the product specification. The total weight was 3.01452 g for one connector. The Cu content was 0.153624 g/g. Notes: No eventual material waste included.	Input	Refined resource	Cu	0.15			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Represents: electricity use for the procuction of ''Other'' component. See the model ''Other component production'' for further details. Method: As we lacked answers for assembly of connector we assumed the same electricity consumption for one gram of connector as for one gram of ''other'' component, i.e. the below mentioned components. Loudspeaker manufacturer	Input	Refined resource	Electricity	6.51			Wh	Technosphere	

states an electricity consumption of 71 Wh for the production of one loudspeaker (''other'' component) which weighs 6,8548 grams. Hence, 71/6,8548 = 10,357 Wh /g other Switch manufacturer states an electricity consumption of 15,2 kJ for the production of one switch (''other'' component) which weighs 1,584 grams. 1 Wh = 3,6 kJ Hence, 15,2/(3,6*1,584) = 2,665 Wh /g other Average value: (10,357 Wh /g other + 2,665 Wh /g other)/2 = 6,51 Wh/g									
Date concieved: 1998 Data type: Derived, unspecified Method: We had earlier made a material declaration of a fork connector by weighing it and looking at the materials stated in the product specification. The total weight was 3.01452 g for one connector. The Ni content was 0.003201 g/g. Notes: No eventual material waste included.	Input	Refined resource	Ni	0.0032			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: We had earlier made a material declaration of a fork connector by weighing it and looking at the materials stated in the product specification. The total weight was 3.01452 g for one connector. The P content was 0.0017 g/g. Notes: No eventual material waste included.	Input	Refined resource	P	0.0017			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: We had earlier made a material declaration of a fork connector by weighing it and looking at the materials stated in the product specification. The total weight was 3.01452 g for one connector. The polyester content was 0.818638 g/g. Notes: The material is glassfilled polyester. Glass fibre amount is 30 % by mass. No eventual material waste included.	Input	Refined resource	Polyester	0.82			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: We had earlier made a material declaration of a fork connector by weighing it and looking at the materials stated in the product specification. The total weight was 3.01452 g for one connector. The Sn content was 0.0154 g/g. Notes: No eventual material waste included.	Input	Refined resource	Sn	0.015			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: We had earlier made a material declaration of a fork connector by weighing it and looking at the materials stated in the product specification. The total weight was 3.01452 g for one connector. The SnPb plating content was 0.0048 g/g. Notes: No eventual material waste included.	Input	Refined resource	SnPb30 plating	0.0048			g	Technosphere	
Date concieved: 1999 Data type: Derived, unspecified Method: Connectors = Life Cycle Inventory model for production of one gram of connectors (applicable to telecommunication equipment).	Output	Product	Connectors	1			g	Technosphere	

About Inventory	
Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI

	General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
	Detailed Purpose	Map a connector manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of connectors and resembling components in our telecom products. The usage for this set of data is life cycle assessments where connectors are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly

	16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to connectors intended for mounting on PC-board in electronic equipment if you know how much the connectors weigh. The model is also intended to be representative for holders in electronic equipment.
About Data	The value for electricity use is based on information acquired from two manufacturers of a loudspeaker and push-button switch, described in the model ''Other electronics production''. The reason for this approximation is that we did not get any usable answer from connector manufacturers. Of all the eighteen models connectors are most similar to the ''other'' components. The raw material input figures have their origin in material declaration of connectors developed at Ericsson. This means that only the amounts included in the product are presented. No waste is included.
Notes	

SPINE LCI dataset: Construction of liquid composting batch system. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Construction of liquid composting batch system. ESA-DBP
Functional Unit	person·year
Functional Unit Explanation	The functional unit chosen is the treatment of one persons sewage and organic waste during one year.
Process Type	Gate to gate
Site	WWTP in Horn, Sweden
Sector	Waste management
Owner	WWTP in Horn, Sweden
Technical system description	Liquid composting batch process was one of the options considered for a little village Horn in the municipality of Västerås, which is a small, planned village of 200 inhabitants situated in a rural area in central Sweden. According to the detailed development plan, 57 houses are to be constructed in this area. The other options were: liquid composting continuous process and conventional waste water treatment plant. The main function of the discussed solution is to treat the toilet and organic kitchen waste. In this solution (excerpt from the report, see 'Publication') ''toilet and kitchen waste is treated batchwise in a liquid composting tank. (...) Grey water (bath, shower and laundry) is treated separately in a sludge separator, filter beds and open ditches. The liquid composted sludge and the filter bed sand are spread on agricultural land.'' The batch system consists of a buffer tank, collection tank and treatment/storage container. ''The composted sludge is pumped to a storage (450 m^3) made of reinforced concrete. The storage is underground, well-covered and mixed in order to minimise emissions of ammonia and methane production. (...) The vacuum unit, the buffer tank and the liquid composting reactor are situated in a building of which is included in the analysis. The building is about 100 m^2 large and consists of a concrete floor, wooden walls and a steel roof and is insulated with stone wool.

	(...) Grey water is transported in a conventional pipe system and treated in a septic tank, sand filters and 40 open ditches before it is released into the lake. One pump station with one pump is estimated to be enough for the small village. The central septic tank (Tremax, ASA 30:25) is designed for 100 pe conventional sewage (black water and grey water). This should be enough considering that it is only grey water that is to be treated. Both the pump station and the septic tank are made of concrete. The electricity demand for pumping wastewater has been calculated for Uppsala city to be 0.8 MJ/m^3. With a grey water production of 55 m^3/pe·y the total electricity demand is 2 500 kWh for Horn village. The sand filters have a total area of 350 m^2 and are provided with two layers of pipes, one for surface distribution of septic tank effluent and one drain system at the bottom of the filter. The PVC pipes are laid in macadam layers (2 x 0.1 m) with 0.8 m sand between.'' This process is included in the system described in: Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf Other processes in the CPM Database also included in the above publication: Operation of waste water treatment plant with urine and sludge separation . ESA-DBP Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP Operation of small-scale waste water treatment plant. ESA-DBP Operation of liquid composting continuous system. ESA-DBP Operation of liquid composting batch process. ESA-DBP Operation of large scale waste water treatment plant. ESA-DBP Construction of small-scale waste water treatment plant. ESA-DBP Construction of liquid composting continous system. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''The operation of the system concerns first of all the emissions to Lake Freden part of Lake Mälaren. But the operation also has impacts on a larger scale, such as emissions of gaseous pollutants and materials produced in other regions.''
Time Boundary	The data were acquired in 1997 as the most up-to-date ones. Excerpt from the report, see 'Publication': ''The study is made for a wastewater system in a village planned to be built in one or two years. The components of the sanitary system are assumed to have a life time of 15 to 30 years.''
Geographical Boundary	The study was done for the village Horn, Sweden. In the construction analysis it is assumed that most of the equipment is made in Sweden, Norway or Finland.
Other Boundaries	Excerpt from the report, see 'Publication': ''The construction does only include the environmental impacts due to the production of the material and not the use, reuse or disposal of the equipment. (...) The transportation of the material is not included in the analysis. (...) According to the detailed development plan, 57 houses are to be constructed in the property of Horn in Västerås municipality.''
Allocations	No information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Some of the data delivered by local authorities and some adapted from the other report
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Production of electricity is not included Local authorities provided site-specific data, while data on equipment were provided by suppliers or estimated from existing systems. General data taken from the literature were used for nutrient content of sewage, the production of precipitation chemicals, fertilizers production, diesel consumption and emissions in the spreading of manure, and the production of different materials.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Additives	1.28E+01			g	Technosphere	Sweden
	Input	Refined resource	Diesel	6.80E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity	1.00E+01			kWh	Technosphere	Sweden
	Input	Resource	*Cr	5.85E+01			g	Technosphere	Sweden
	Input	Resource	*Fe	4.99E+02			g	Technosphere	Sweden
	Input	Resource	*Ni	2.60E+01			g	Technosphere	Sweden
	Input	Resource	Aggregates	3.34E+04			g	Technosphere	Sweden
	Input	Resource	Alloy materials	1.53E+02			g	Technosphere	Sweden
	Input	Resource	Bauxite	2.80E-01			g	Technosphere	Sweden
	Input	Resource	Blast-furnace gas	-8.50E-01			MJ	Technosphere	Sweden
	Input	Resource	Chemicals	1.40E+01			g	Technosphere	Sweden
	Input	Resource	China-clay	8.55E+01			g	Technosphere	Sweden
	Input	Resource	Coal	5.59E+01			MJ	Technosphere	Sweden
	Input	Resource	Coke	6.48E+00			g	Technosphere	Sweden
	Input	Resource	Coke	9.86E+00			MJ	Technosphere	Sweden
	Input	Resource	Coke gas	-2.20E-01			MJ	Technosphere	Sweden
	Input	Resource	Diabase	3.51E+01			g	Technosphere	Sweden
	Input	Resource	Dolomite	7.20E+00			g	Technosphere	Sweden
	Input	Resource	Explosives	4.30E+00			g	Technosphere	Sweden
	Input	Resource	Feldspar	4.28E+01			g	Technosphere	Sweden
	Input	Resource	Gas	5.53E+01			MJ	Technosphere	Sweden
	Input	Resource	Grind media	5.70E-01			g	Technosphere	Sweden
	Input	Resource	Gypsum	2.90E+02			g	Technosphere	Sweden
	Input	Resource	Iron ore	5.51E+03			g	Technosphere	Sweden
	Input	Resource	Iron sulphate	5.82E+01			g	Technosphere	Sweden
	Input	Resource	Limestone	9.15E+03			g	Technosphere	Sweden
	Input	Resource	Macadam	1.00E-02			m3	Technosphere	Sweden
	Input	Resource	Minerals	5.17E+02			g	Technosphere	Sweden
	Input	Resource	NaCl	1.65E+03			g	Technosphere	Sweden
	Input	Resource	Oil	5.76E+01			MJ	Technosphere	Sweden
	Input	Resource	Phenol	5.40E-01			g	Technosphere	Sweden
	Input	Resource	Quartzite	3.35E+02			g	Technosphere	Sweden
	Input	Resource	Sand	1.75E+03			g	Technosphere	Sweden
	Input	Resource	Steel scrap	1.99E+03			g	Technosphere	Sweden
	Input	Resource	Urea	3.60E-01			g	Technosphere	Sweden
	Input	Resource	Waste oil	7.86E+01			g	Technosphere	Sweden
	Input	Resource	Wood	1.00E+02			g	Technosphere	Sweden
	Output	Emission	Acidification eq.	1.80E-01			g	Water	Sweden
	Output	Emission	Al	1.32E-03			g	Water	Sweden
	Output	Emission	As	2.00E-06			g	Water	Sweden
	Output	Emission	As	4.69E-04			g	Air	Sweden
	Output	Emission	BOD	1.00E-01			g	Water	Sweden
	Output	Emission	Ca	3.50E-03			g	Air	Sweden
	Output	Emission	Cd	1.10E-04			g	Air	Sweden
	Output	Emission	CH4	1.25E+01			g	Air	Sweden
	Output	Emission	Chlorides	4.34E+01			g	Water	Sweden
	Output	Emission	CO	9.33E+00			g	Air	Sweden
	Output	Emission	CO2	1.24E+04			g	Air	Sweden
	Output	Emission	COD	1.26E+00			g	Water	Sweden
	Output	Emission	Cr	1.02E-03			g	Air	Sweden
	Output	Emission	Cr	1.23E-04			g	Water	Sweden
	Output	Emission	Cu	2.58E-04			g	Water	Sweden
	Output	Emission	Cu	6.87E-04			g	Air	Sweden
	Output	Emission	Dioxine	2.00E-05			g	Water	Sweden
	Output	Emission	Dissolved solids	1.41E+00			g	Water	Sweden
	Output	Emission	F	5.00E-06			g	Water	Sweden
	Output	Emission	Fe	1.00E-02			g	Water	Sweden
	Output	Emission	Fe	4.11E-02			g	Air	Sweden
	Output	Emission	Formaldehyde	3.60E-03			g	Air	Sweden
	Output	Emission	H2S	3.42E-04			g	Air	Sweden
	Output	Emission	HC	2.57E+01			g	Air	Sweden
	Output	Emission	HCl	3.64E-01			g	Air	Sweden
	Output	Emission	HF	1.43E-01			g	Air	Sweden

	Output	Emission	Hg	1.28E-04			g	Air	Sweden
	Output	Emission	Metals	3.67E-04			g	Air	Sweden
	Output	Emission	Metals	6.89E-02			g	Water	Sweden
	Output	Emission	Mn	1.00E-02			g	Water	Sweden
	Output	Emission	Mn	6.10E-05			g	Air	Sweden
	Output	Emission	N2O	6.62E-04			g	Air	Sweden
	Output	Emission	Na+ (aq)	4.94E+00			g	Water	Sweden
	Output	Emission	NH3	3.68E-02			g	Air	Sweden
	Output	Emission	NH3	8.75E-04			g	Water	Sweden
	Output	Emission	Ni	1.05E-03			g	Air	Sweden
	Output	Emission	Ni	2.08E-04			g	Water	Sweden
	Output	Emission	NOx	4.30E+01			g	Air	Sweden
	Output	Emission	N-tot	1.10E-01			g	Water	Sweden
	Output	Emission	Oil	1.24E-02			g	Air	Sweden
	Output	Emission	Oil	7.24E+00			MJ	Water	Sweden
	Output	Emission	Oil (aq)	5.15E-02			g	Water	Sweden
	Output	Emission	PAH	5.00E-04			g	Air	Sweden
	Output	Emission	Particles	6.18E+00			g	Air	Sweden
	Output	Emission	Pb	1.02E-03			g	Water	Sweden
	Output	Emission	Pb	8.69E-03			g	Air	Sweden
	Output	Emission	Phenol	1.00E-06			g	Water	Sweden
	Output	Emission	Phenol	4.29E-03			g	Water	Sweden
	Output	Emission	Phenol	5.44E-03			g	Air	Sweden
	Output	Emission	P-tot	1.73E-04			g	Air	Sweden
	Output	Emission	P-tot	2.03E-03			g	Water	Sweden
	Output	Emission	SO2	2.89E+01			g	Air	Sweden
	Output	Emission	SO4--(air)	6.90E-03			g	Air	Sweden
	Output	Emission	SO4--(aq)	1.77E+00			g	Water	Sweden
	Output	Emission	SOx	3.76E-01			g	Air	Sweden
	Output	Emission	Sr (aq)	8.93E-02			g	Water	Sweden
	Output	Emission	Susp solids	7.93E+00			g	Water	Sweden
	Output	Emission	Tl	6.79E-04			g	Air	Sweden
	Output	Emission	TOC	5.31E-02			g	Water	Sweden
	Output	Emission	Tot-CN	3.96E-04			g	Water	Sweden
	Output	Emission	VOC	8.20E-01			g	Air	Sweden
	Output	Emission	Zn	3.92E-02			g	Air	Sweden
	Output	Emission	Zn	8.47E-04			g	Water	Sweden
	Output	Residue	Ashes	1.48E+01			g	Technosphere	Sweden
	Output	Residue	Dust	4.48E+00			g	Technosphere	Sweden
	Output	Residue	Hazardous waste	7.90E+00			g	Technosphere	Sweden
	Output	Residue	HC, chlorinated	5.25E-01			g	Technosphere	Sweden
	Output	Residue	Industrial waste	1.09E+03			g	Technosphere	Sweden
	Output	Residue	Mineral waste	2.85E+03			g	Technosphere	Sweden
	Output	Residue	Non-toxic chemicals	1.27E+01			g	Technosphere	Sweden
	Output	Residue	Waste	1.95E+02			g	Technosphere	Sweden

About Inventory

Publication	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf
Intended User	LCA practitioner, Waste Water Treatment System Specialist
General Purpose	Excerpt from the report, see 'Publication': ''The LCAs were performed on planned wastewater systems in areas within three Swedish minicipalities; Luleå, Västerås and Strömstad. Apart from the case studies a literature study of substitutability of nutrients in sewage compared to artificial fertilizers was performed.''
Detailed Purpose	Horn was chosen as an example of small community. Excerpt from the report, see 'Publication': ''This study has been made in order to find out the environmental consequences of two alternatives for the handling of organic waste and sewage for the village of Horn. (...) The question the LCA should answer is: Which technical solution will give the least environmental impact, to treat the toilet and organic kitchen waste by liquid-composting or to treat the wastewater in a small sewage plant and the compostable kitchen waste in a drum compost''

Commissioner	Swedish Environmental Agency - .
Practitioner	Lundin, Margareta - .
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The results from the project were also used in the following paper: Lundin M., Bengtsson M., Molander S. (2000). Life Cycle Assessment of Wastewater Systems: Influence of System Boundaries and Scale on Calculated Environmental Loads. Technical Environmental Planning, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf

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SPINE LCI dataset: Construction of liquid composting continous system. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Construction of liquid composting continous system. ESA-DBP
Functional Unit	person·year
Functional Unit Explanation	The functional unit chosen is the treatment of one persons sewage and organic waste during one year. The sewage treatment includes black water and grey water.
Process Type	Gate to gate
Site	WWTP in Horn, Sweden
Sector	Waste management
Owner	WWTP in Horn, Sweden
Technical system description	Liquid composting continuous process was one of the options considered for a little village Horn in the municipality of Västerås, which is a small, planned village of 200 inhabitants situated in a rural area in central Sweden. According to the detailed development plan, 57 houses are to be constructed in this area. The other options were: liquid composting batch process and conventional waste water treatment plant. The main function of the discussed solution is to treat the toilet and organic kitchen waste. In this solution (excerpt from the report, see 'Publication') ''toilet and kitchen waste is treated continuously in a liquid composting reactor. Grey water (bath, shower and laundry) is treated separately in a sludge separator, filter beds and open ditches. The liquid composted sludge and the filter bed sand are spread on agricultural land. The plant consists of the technical components, such as the buffer tank, liquid compost reactor and sludge storage. The most common materials would be aggregates, steel and plastics. ''The vacuum unit, the buffer tank and the liquid composting reactor are situated in a building of which is included in the analysis. The building is about 100 m² large and consists

	of a concrete floor, wooden walls and a steel roof and is insulated with stone wool. (...) Grey water is transported in a conventional pipe system and treated in a septic tank, sand filters and 40 open ditches before it is released into the lake. One pump station with one pump is estimated to be enough for the small village. The central septic tank (Tremax, ASA 30:25) is designed for 100 pe conventional sewage (black water and grey water). This should be enough considering that it is only grey water that is to be treated. Both the pump station and the septic tank are made of concrete. The electricity demand for pumping wastewater has been calculated for Uppsala city to be 0.8 MJ/m³. With a grey water production of 55 m³/pe·y the total electricity demand is 2 500 kWh for Horn village. The sand filters have a total area of 350 m² and are provided with two layers of pipes, one for surface distribution of septic tank effluent and one drain system at the bottom of the filter. The PVC pipes are laid in macadam layers (2 x 0.1 m) with 0.8 m sand between.'' This process is included in the system described in: Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf Other processes in the CPM Database also included in the above publication: Operation of waste water treatment plant with urine and sludge separation . ESA-DBP Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP Operation of small-scale waste water treatment plant. ESA-DBP Operation of liquid composting continuous system. ESA-DBP Operation of liquid composting batch process. ESA-DBP Operation of large scale waste water treatment plant. ESA-DBP Construction of small-scale waste water treatment plant. ESA-DBP Construction of liquid composting batch system. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''The operation of the system concerns first of all the emissions to Lake Freden part of Lake Mälaren. But the operation also has impacts on a larger scale, such as emissions of gaseous pollutants and materials produced in other regions.''
Time Boundary	The data were acquired in 1997 as the most up-to-date ones. Excerpt from the report, see 'Publication': ''The study is made for a wastewater system in a village planned to be built in one or two years. The components of the sanitary system are assumed to have a life time of 15 to 30 years.''
Geographical Boundary	The study was done for the village Horn, Sweden. In the construction analysis it is assumed that most of the equipment is made in Sweden, Norway or Finland.
Other Boundaries	Excerpt from the report, see 'Publication': ''The production of chemicals and other types of 35 materials needed are included (...). The construction does only include the environmental impacts due to the production of the material and not the use, reuse or disposal of the equipment. (...) The transportation of the material is not included in the analysis.'' Production of electricity is excluded from the study.
Allocations	No information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Local authorities provided site-specific data, while data on equipment were provided by suppliers or estimated from existing systems. General data taken from the literature were used for nutrient content of sewage, the production of precipitation chemicals, fertilizers production, diesel consumption and emissions in the spreading of manure, and the production of different materials.

Flow Table and Specific Meta Data									
QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Wood	1.04E+02			g	Technosphere	Sweden
	Input	Refined resource	Additives	6.88E+00			g	Technosphere	Sweden
	Input	Refined resource	Alloy materials	7.76E+01			g	Technosphere	Sweden
	Input	Refined resource	Chemicals	7.24E+00			g	Technosphere	Sweden
	Input	Refined resource	China-clay	1.32E+02			g	Technosphere	Sweden
	Input	Refined resource	Clay	4.94E-03			g	Technosphere	Sweden
	Input	Refined resource	Coke	6.50E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Diesel	4.50E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity	8.60E+00			kWh	Technosphere	Sweden
	Input	Refined resource	Explosives	2.47E+00			g	Technosphere	Sweden
	Input	Refined resource	Fire proof stone	1.88E-01			g	Technosphere	Sweden
	Input	Refined resource	Grind media	3.63E-01			g	Technosphere	Sweden
	Input	Refined resource	Gypsum	1.84E+02			g	Technosphere	Sweden
	Input	Refined resource	H2SO4	2.11E+00			g	Technosphere	Sweden
	Input	Refined resource	Insulation stone	3.13E-01			g	Technosphere	Sweden
	Input	Refined resource	Ironsulphate	3.69E+01			g	Technosphere	Sweden
	Input	Refined resource	NaCl	2.45E+03			g	Technosphere	Sweden
	Input	Refined resource	Oil	6.22E+01			MJ	Technosphere	Sweden
	Input	Refined resource	Phenol	9.00E-01			g	Technosphere	Sweden
	Input	Refined resource	Steel scrap	6.43E+02			g	Technosphere	Sweden
	Input	Refined resource	Urea	6.00E-01			g	Technosphere	Sweden
	Input	Refined resource	Waste oil	4.98E+01			g	Technosphere	Sweden
	Input	Resource	*Cr	5.85E+01			g	Technosphere	Sweden
	Input	Resource	*Fe	4.99E+02			g	Technosphere	Sweden
	Input	Resource	*Ni	2.60E+01			g	Technosphere	Sweden
	Input	Resource	Aggregates	2.11E+04			g	Technosphere	Sweden
	Input	Resource	Bauxite	1.77E+02			g	Technosphere	Sweden
	Input	Resource	Blast-furnace gas	-8.54E-01			MJ	Technosphere	Sweden
	Input	Resource	Coal	3.78E+01			MJ	Technosphere	Sweden
	Input	Resource	Coke	1.08E+01			g	Technosphere	Sweden
	Input	Resource	Coke gas	-2.20E-01			MJ	Technosphere	Sweden
	Input	Resource	Colemanite	1.77E+01			g	Technosphere	Sweden
	Input	Resource	Diabase	5.85E+01			g	Technosphere	Sweden
	Input	Resource	Dolomite	1.20E+01			g	Technosphere	Sweden
	Input	Resource	Feldspar	4.28E+01			g	Technosphere	Sweden
	Input	Resource	Fluorspar	1.75E+00			g	Technosphere	Sweden
	Input	Resource	Gas	5.52E+01			MJ	Technosphere	Sweden
	Input	Resource	Iron ore	3.50E+03			g	Technosphere	Sweden
	Input	Resource	Iron ore	5.20E+03			g	Ground	Sweden
	Input	Resource	Limestone	5.81E+03			g	Technosphere	Sweden
	Input	Resource	Macadam	1.17E-02			m3	Technosphere	Sweden
	Input	Resource	Minerals	2.78E+02			g	Technosphere	Sweden
	Input	Resource	Ni	2.60E+01			g	Technosphere	Sweden
	Input	Resource	Quartzite	2.27E+02			g	Technosphere	Sweden
	Input	Resource	Sand	1.76E+03			m3	Technosphere	Sweden
	Output	Emission	Acidification eq.	1.76E-01			g	Water	Sweden
	Output	Emission	Al	7.11E-04			g	Water	Sweden
	Output	Emission	As	2.00E-06			g	Water	Sweden
	Output	Emission	As	4.48E-04			g	Air	Sweden
	Output	Emission	BOD	1.70E-01			g	Water	Sweden
	Output	Emission	Ca	1.07E-03			g	Air	Sweden
	Output	Emission	Cd	6.50E-05			g	Air	Sweden
	Output	Emission	CH4	7.49E+00			g	Air	Sweden
	Output	Emission	Chloride	4.34E+01			g	Water	Sweden
	Output	Emission	Cl2	1.52E-03			g	Air	Sweden
	Output	Emission	CO	6.98E+00			g	Air	Sweden
	Output	Emission	CO2	9.31E+03			g	Air	Sweden
	Output	Emission	COD	2.98E+00			g	Water	Sweden
	Output	Emission	Cr	3.83E-04			g	Air	Sweden
	Output	Emission	Cr	6.70E-05			g	Water	Sweden
	Output	Emission	Cu	1.39E-04			g	Water	Sweden
	Output	Emission	Cu	3.14E-04			g	Air	Sweden

	Output	Emission	Dioxin	2.00E-05			g	Water	Sweden
	Output	Emission	Dissolved solids	8.05E-01			g	Water	Sweden
	Output	Emission	F	5.94E-02			g	Water	Sweden
	Output	Emission	Fe	1.26E-02			g	Air	Sweden
	Output	Emission	Fe	6.12E-03			g	Water	Sweden
	Output	Emission	Formaldehyde	6.00E-03			g	Air	Sweden
	Output	Emission	H2S	1.94E-03			g	Air	Sweden
	Output	Emission	HC	2.74E+01			g	Air	Sweden
	Output	Emission	HCl	3.22E-01			g	Air	Sweden
	Output	Emission	HF	7.71E-02			g	Air	Sweden
	Output	Emission	Hg	7.40E-05			g	Air	Sweden
	Output	Emission	Mn	3.30E-05			g	Air	Sweden
	Output	Emission	Mn	4.72E-03			g	Water	Sweden
	Output	Emission	N2O	2.29E-03			g	Air	Sweden
	Output	Emission	Na	4.94E+00			g	Water	Sweden
	Output	Emission	NH3	2.68E-04			g	Water	Sweden
	Output	Emission	NH3	5.84E-02			g	Air	Sweden
	Output	Emission	Ni	1.12E-04			g	Water	Sweden
	Output	Emission	Ni	5.56E-04			g	Air	Sweden
	Output	Emission	NOx	3.58E+01			g	Air	Sweden
	Output	Emission	N-tot	7.95E-02			g	Water	Sweden
	Output	Emission	Oil	4.20E-03			g	Air	Sweden
	Output	Emission	Oil	5.15E-02			g	Water	Sweden
	Output	Emission	PAH	1.06E-03			g	Air	Sweden
	Output	Emission	Particles	5.00E+00			g	Air	Sweden
	Output	Emission	Pb	5.55E-03			g	Air	Sweden
	Output	Emission	Pb	5.57E-04			g	Water	Sweden
	Output	Emission	Phenol	1.10E-05			g	Water	Sweden
	Output	Emission	Phenol	9.03E-03			g	Air	Sweden
	Output	Emission	P-tot	1.59E-03			g	Water	Sweden
	Output	Emission	P-tot	1.73E-04			g	Air	Sweden
	Output	Emission	SO2	2.71E+01			g	Air	Sweden
	Output	Emission	SO2	2.99E-01			g	Water	Sweden
	Output	Emission	SO4	2.01E+00			g	Water	Sweden
	Output	Emission	SO4	2.11E-03			g	Air	Sweden
	Output	Emission	SOx	3.76E-01			g	Air	Sweden
	Output	Emission	Sr	3.04E-02			g	Water	Sweden
	Output	Emission	Susp solids	8.30E+00			g	Water	Sweden
	Output	Emission	THC	4.14E-03			g	Air	Sweden
	Output	Emission	Tl	4.30E-04			g	Air	Sweden
	Output	Emission	TOC	5.60E-02			g	Water	Sweden
	Output	Emission	Tot-CN	3.96E-04			g	Water	Sweden
	Output	Emission	VOC	5.19E-01			g	Air	Sweden
	Output	Emission	Zn	1.42E-02			g	Air	Sweden
	Output	Emission	Zn	8.47E-04			g	Water	Sweden
	Output	Residue	Anhydrite waste	2.16E+00			g	Technosphere	Sweden
	Output	Residue	Ashes	2.24E+01			g	Technosphere	Sweden
	Output	Residue	Coal	3.60E-01			g	Technosphere	Sweden
	Output	Residue	Dust	4.48E+00			g	Technosphere	Sweden
	Output	Residue	Electrolysis bath	3.96E-01			g	Technosphere	Sweden
	Output	Residue	Hazardous waste	5.90E+00			g	Technosphere	Sweden
	Output	Residue	Hazardous waste	6.00E+00			g	Technosphere	Sweden
	Output	Residue	HC, chlorinated	5.25E-01			g	Technosphere	Sweden
	Output	Residue	Industrial waste	6.01E+02			g	Technosphere	Sweden
	Output	Residue	Mineral waste	1.57E+03			g	Technosphere	Sweden
	Output	Residue	Non-toxic chemicals	1.27E+01			g	Technosphere	Sweden
	Output	Residue	Waste	2.20E+02			g	Technosphere	Sweden

About Inventory

Publication	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf

Intended User	LCA practitioner, Waste Water Treatment System Specialist
General Purpose	Excerpt from the report, see 'Publication': ''The LCAs were performed on planned wastewater systems in areas within three Swedish minicipalities; Luleå, Västerås and Strömstad. Apart from the case studies a literature study of substitutability of nutrients in sewage compared to artificial fertilizers was performed.''
Detailed Purpose	Horn was chosen as an example of small community. Excerpt from the report, see 'Publication': ''This study has been made in order to find out the environmental consequences of two alternatives for the handling of organic waste and sewage for the village of Horn. (...) The question the LCA should answer is: Which technical solution will give the least environmental impact, to treat the toilet and organic kitchen waste by liquid-composting or to treat the wastewater in a small sewage plant and the compostable kitchen waste in a drum compost''
Commissioner	Swedish Environmental Agency - .
Practitioner	Lundin, Margareta - .
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The results from the project were also used in the following paper: Lundin M., Bengtsson M., Molander S. (2000). Life Cycle Assessment of Wastewater Systems: Influence of System Boundaries and Scale on Calculated Environmental Loads. Technical Environmental Planning, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf

SPINE LCI dataset: Construction of small-scale waste water treatment plant. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Construction of small-scale waste water treatment plant. ESA-DBP
Functional Unit	person·year
Functional Unit Explanation	The functional unit chosen is the treatment of one persons sewage and organic waste during one year.
Process Type	Gate to gate
Site	WWTP in Horn, Sweden
Sector	Waste management
Owner	WWTP in Horn, Sweden
Technical system description	Small waste water treatment process was one of the options considered for a little village Horn in the municipality of Västerås, which is a small, planned village of 200 inhabitants situated in a rural area in central Sweden. The other options were: liquid composting continuous process and liquid composting batch

	process. Excerpt from the report, see 'Publication': ''In the (...) WWTP, all wastewater is treated in a small wastewater treatment plant consisting of mechanical, biological and chemical steps. The organic kitchen waste is treated separately in a common drum compost. After storage the sludge is spread on agricultural land while the compost is used in the residents' gardens. The system consists of drum compost container and storage, sewage plant, sludge storage and UV basin. ''The plant is placed in a building (35 m^2) which is included in the analysis. The sludge from the process is pumped to a concrete storage tank (100 m^3). The tank is underground, covered and the sludge is mixed to avoid emissions of NH3, CH4 and odour. Sewage sludge is stored up to one year before it is spread on arable land.'' This process is included in the system described in: Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf Other processes in the CPM Database also included in the above publication: Operation of waste water treatment plant with urine and sludge separation . ESA-DBP Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP Operation of small-scale waste water treatment plant. ESA-DBP Operation of liquid composting continuous system. ESA-DBP Operation of liquid composting batch process. ESA-DBP Operation of large scale waste water treatment plant. ESA-DBP Construction of liquid composting continous system. ESA-DBP Construction of liquid composting batch system. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''The construction does only include the environmental impacts due to the production of the material and not the use, reuse or disposal of the equipment.''
Time Boundary	The data were acquired in 1997 as the most up-to-date ones. Pumps, tanks, and other technical parts were expected to last for 15 years; buildings, filter beds, and pipes were expected to last for 30 years; and toilets were expected to last for 25 years.
Geographical Boundary	The study was done for the village Horn, Sweden. In the construction analysis it is assumed that most of the equipment is made in Sweden, Norway or Finland.
Other Boundaries	The transportation of the material to the construction site was not included. The construction of UV-basin nor the production and disposal of mercury lamps are either not considered in the study.
Allocations	No information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Some of the data delivered by local authorities and some adapted from the other report
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Production of electricity is not included Local authorities provided site-specific data, while data on equipment were provided by suppliers or estimated from existing systems. General data taken from the literature were used for nutrient content of sewage, the production of precipitation chemicals, fertilizers production, diesel consumption and emissions in the spreading of manure, and the production of different materials.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Additives	4.21E+00			g	Technosphere	Sweden
	Input	Refined resource	Aggregates	9.70E+03			g	Technosphere	Sweden
	Input	Refined resource	Alloy materials	4.47E+01			g	Technosphere	Sweden
	Input	Refined resource	Blast-furnace gas	-9.36E+02			MJ	Technosphere	Sweden
	Input	Refined resource	Chemicals	4.29E+00			g	Technosphere	Sweden
	Input	Refined resource	Diesel	5.08E-02			g	Technosphere	Sweden
	Input	Refined resource	Electricity	5.10E+00			g	Technosphere	Sweden
	Input	Refined resource	Explosives	1.35E+00			g	Technosphere	Sweden
	Input	Resource	*Cr	1.02E+00			g	Technosphere	Sweden
	Input	Resource	*Fe	6.07E+01			g	Technosphere	Sweden
	Input	Resource	*Ni	4.52E-01			g	Technosphere	Sweden
	Input	Resource	*Sand	6.24E+01			g	Technosphere	Sweden
	Input	Resource	Bauxite	4.51E+00			g	Technosphere	Sweden
	Input	Resource	China-clay	1.83E+02			g	Technosphere	Sweden
	Input	Resource	Clay	5.90E-03			g	Technosphere	Sweden
	Input	Resource	Coal	4.37E+02			g	Technosphere	Sweden
	Input	Resource	Coal	8.12E+00			MJ	Technosphere	Sweden
	Input	Resource	Coke	2.79E+00			g	Technosphere	Sweden
	Input	Resource	Coke gas	-2.38E-02			g	Technosphere	Sweden
	Input	Resource	Colemanite	2.44E+01			g	Technosphere	Sweden
	Input	Resource	Feldspar	5.94E+01			g	Technosphere	Sweden
	Input	Resource	Fire proof stone	4.44E-03			g	Technosphere	Sweden
	Input	Resource	Fluorspar	4.12E-02			g	Technosphere	Sweden
	Input	Resource	Gas	2.73E+01			MJ	Technosphere	Sweden
	Input	Resource	Gas	4.47E+02			g	Technosphere	Sweden
	Input	Resource	Grind media	1.67E-01			g	Technosphere	Sweden
	Input	Resource	Gypsum	8.44E+01			g	Technosphere	Sweden
	Input	Resource	H2SO4	4.98E-02			g	Technosphere	Sweden
	Input	Resource	Insulation stone	7.40E-03			g	Technosphere	Sweden
	Input	Resource	Iron ore	1.83E+03			g	Technosphere	Sweden
	Input	Resource	Iron sulphate	1.69E+01			g	Technosphere	Sweden
	Input	Resource	Limestone	2.72E+03			g	Technosphere	Sweden
	Input	Resource	Minerals	1.70E+02			g	Technosphere	Sweden
	Input	Resource	NaCl	2.78E+03			g	Technosphere	Sweden
	Input	Resource	Oil	1.36E+01			MJ	Technosphere	Sweden
	Input	Resource	Oil	7.93E+02			g	Technosphere	Sweden
	Input	Resource	Quartzite	1.44E+02			g	Technosphere	Sweden
	Input	Resource	Steel scrap	2.10E+02			g	Technosphere	Sweden
	Input	Resource	Waste oil	2.28E+01			g	Technosphere	Sweden
	Input	Resource	Wood	1.23E+02			g	Technosphere	Sweden
	Output	Emission	Acidification eq.	1.37E-01			g	Water	Sweden
	Output	Emission	As	1.00E-06			g	Water	Sweden
	Output	Emission	As	3.57E-04			g	Air	Sweden
	Output	Emission	BOD	1.05E-01			g	Water	Sweden
	Output	Emission	Ca	3.12E-04			g	Air	Sweden
	Output	Emission	Cd	2.80E-05			g	Air	Sweden
	Output	Emission	CH4	4.93E+00			g	Air	Sweden
	Output	Emission	Chloride	3.40E+01			g	Water	Sweden
	Output	Emission	Cl2	3.60E-05			g	Air	Sweden
	Output	Emission	CO	4.18E+00			g	Air	Sweden
	Output	Emission	CO2	5.24E+03			g	Air	Sweden
	Output	Emission	COD	1.53E+00			g	Water	Sweden
	Output	Emission	Coke gas	7.08E-03			g	Water	Sweden
	Output	Emission	Cr	1.47E-04			g	Air	Sweden
	Output	Emission	Cr	4.10E-05			g	Water	Sweden
	Output	Emission	Cu	1.68E-04			g	Air	Sweden
	Output	Emission	Cu	8.40E-05			g	Water	Sweden
	Output	Emission	Dioxin	4.00E-06			g	Water	Sweden
	Output	Emission	Dissolved solids	5.41E-01			g	Water	Sweden
	Output	Emission	F	1.40E-03			g	Water	Sweden
	Output	Emission	Fe	3.66E-03			g	Air	Sweden
	Output	Emission	Fe	4.92E-03			g	Water	Sweden
	Output	Emission	H2S	2.57E-03			g	Air	Sweden
	Output	Emission	HC	2.41E+01			g	Air	Sweden

	Output	Emission	HCl	2.49E-01			g	Air	Sweden
	Output	Emission	HF	4.74E-02			g	Air	Sweden
	Output	Emission	Hg	4.00E-05			g	Air	Sweden
	Output	Emission	Mn	2.10E-05			g	Air	Sweden
	Output	Emission	Mn	2.59E-03			g	Water	Sweden
	Output	Emission	N2O	3.08E-03			g	Air	Sweden
	Output	Emission	NaCl	3.84E+00			g	Water	Sweden
	Output	Emission	NH3	3.54E-03			g	Air	Sweden
	Output	Emission	NH3	7.80E-05			g	Water	Sweden
	Output	Emission	Ni	3.37E-04			g	Air	Sweden
	Output	Emission	Ni	6.80E-05			g	Water	Sweden
	Output	Emission	NOx	2.59E+01			g	Air	Sweden
	Output	Emission	N-tot	4.55E-02			g	Water	Sweden
	Output	Emission	Oil	1.53E-03			g	Air	Sweden
	Output	Emission	Oil	4.70E-05			g	Water	Sweden
	Output	Emission	PAH	1.54E-04			g	Air	Sweden
	Output	Emission	Particles	1.84E+00			g	Air	Sweden
	Output	Emission	Pb	3.35E-04			g	Water	Sweden
	Output	Emission	Pb	8.44E-04			g	Air	Sweden
	Output	Emission	Phenol	1.00E-06			g	Water	Sweden
	Output	Emission	Phenol	1.20E-05			g	Air	Sweden
	Output	Emission	Phenol	8.96E-04			g	Water	Sweden
	Output	Emission	P-tot	1.29E-03			g	Water	Sweden
	Output	Emission	P-tot	3.80E-05			g	Air	Sweden
	Output	Emission	SO2	1.66E+01			g	Air	Sweden
	Output	Emission	SO2	7.06E-03			g	Water	Sweden
	Output	Emission	SO4	1.38E+00			g	Water	Sweden
	Output	Emission	SO4	6.15E-04			g	Air	Sweden
	Output	Emission	SOx	4.03E-01			g	Air	Sweden
	Output	Emission	Sr	1.11E-02			g	Water	Sweden
	Output	Emission	Susp solids	9.20E+00			g	Water	Sweden
	Output	Emission	THC	9.80E-05			g	Air	Sweden
	Output	Emission	Tl	1.97E-04			g	Air	Sweden
	Output	Emission	TOC	6.21E-02			g	Water	Sweden
	Output	Emission	Tot-CN	4.30E-05			g	Water	Sweden
	Output	Emission	VOC	2.38E-01			g	Air	Sweden
	Output	Emission	Zn	5.76E-03			g	Air	Sweden
	Output	Emission	Zn	6.83E-04			g	Water	Sweden
	Output	Residue	Anhydrite waste	5.90E-02			g	Technosphere	Sweden
	Output	Residue	Ashes	1.24E+01			g	Technosphere	Sweden
	Output	Residue	Dust	3.67E+00			g	Technosphere	Sweden
	Output	Residue	Electrolysis bath	9.35E-03			g	Technosphere	Sweden
	Output	Residue	Hazardous waste	4.19E+00			g	Technosphere	Sweden
	Output	Residue	HC, chlorinated	4.08E-01			g	Technosphere	Sweden
	Output	Residue	Industrial waste	2.87E+02			g	Technosphere	Sweden
	Output	Residue	Mineral waste	9.71E+02			g	Technosphere	Sweden
	Output	Residue	Non-toxic chemicals	1.02E+01			g	Technosphere	Sweden
	Output	Residue	Waste	5.90E+01			g	Technosphere	Sweden

About Inventory

Publication	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf
Intended User	LCA practitioner, Waste Water Treatment System Specialist
General Purpose	Excerpt from the report, see 'Publication': ''The LCAs were performed on planned wastewater systems in areas within three Swedish minicipalities; Luleå, Västerås and Strömstad. Apart from the case studies a literature study of substitutability of nutrients in sewage compared to artificial fertilizers was performed.''
Detailed Purpose	Horn was chosen as an example of small community. Excerpt from the report, see 'Publication': ''This study has been made in order to find out the environmental consequences of two alternatives for the handling of organic waste and sewage for the village of Horn. (...) The question the LCA should answer is: Which technical solution will give the least

	environmental impact, to treat the toilet and organic kitchen waste by liquid-composting or to treat the wastewater in a small sewage plant and the compostable kitchen waste in a drum compost''
Commissioner	Swedish Environmental Agency - .
Practitioner	Lundin, Margareta - .
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The results from the study are also discussed in the publication: Lundin M., (1999). Assessment of the Environmental Sustainability of Urban Water Systems. Report TEP 1999:7, ISSN 1400-9560, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1999--7.pdf

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SPINE LCI dataset: Converting waste-oil into fuel oil AGGR

Flow Chart

This data set transparently reported, including a flowchart where each process is individually described

Administrative	
Finished	Y
Date Completed	1999
Copyright	
Availability	

Technical System	
Name	Converting waste-oil into fuel oil AGGR
Functional Unit	1 m3 converted fuel oil
Functional Unit Explanation	
Process Type	Gate to gate
Site	
Sector	Waste treatment
Owner	
Technical system description	The waste oil origin from the industries that consume oil products e.g. as lubrication and in cooling processes. A sludge-suction truck generally carries out the local collection. However, the gate of the LCA is located at a later stage where the waste oil is stored in tanks and cisterns. The oil is collected and stored in Stockholm (Loudden), Jönköping, Göteborg, Umeå, Luleå and Halmstad. The waste oil is transported from Umeå and Luleå to Halmstad (Processing waste oil into fuel oil) by train. From Loudden the waste oil is transported to Halmstad by vessel. The waste oil that is collected and stored in Jönköping is transported to Halmstad by truck. The waste oil that is locally collected at the facility in Göteborg (Treatment of waste oil from municipalities, Treatment of oil-contaminated waste water) undergoes a first phase of pre-treatment before being transported to Halmstad by vessel. Some of the waste (scrap) is sent to Sävenäs (Combustion of waste) waste treatment facility for combustion.

When the waste oil is delivered to Halmstad it is evaluated for PCB. The treatment facility in Halmstad does not possess the technique to treat PCB-contaminated waste oil, and is therefore sent to SAKAB in Kumla (Treatment of hazardous waste) for final treatment. This activity is not a standard procedure when producing converted fuel oil and is therefore neglected in the study. The final refinement is achieved in Halmstad, where water and wastes are extracted and the waste oil is converted into fuel oil. The extracted water from the waste oil is treated before being let out to the recipient, the Halmstad harbour. The waste substance (water-sludge) that origins from the water treatment in Halmstad is transported to Göteborg by truck where it is treated in the de-watering facility (De-watering of water-sludge). The solid phase of the water-sludge is discharged at Torsviken. The derived scrap from the treatment process in Halmstad is transported by truck to Reci in Göteborg where the scrap in temporary stored. The scrap is later sent to Sävenäs waste treatment facility. The oil-sludge developed during the oil treatment process in Göteborg and Halmstad is transported by truck to SAKAB for treatment. The converted fuel oil is transported by vessel from Halmstad to the cement production facility at Slite.

Flowchart

Click on flowchart to open each data set description

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	Some of the data delivered by local authorities and some adapted from the other report
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Production of electricity is not included Local authorities provided site-specific data, while data on equipment were provided by suppliers or estimated from existing systems. General data taken from the literature were used for nutrient content of sewage, the production of precipitation chemicals, fertilizers production, diesel consumption and emissions in the spreading of manure, and the production of different materials.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Alpoclar 200	0.274			kg	Technosphere	
	Input	Refined resource	Aluminium sulphate	0.030			kg	Technosphere	
Notes: 25%	Input	Refined resource	Ammonia	0.028			kg	Technosphere	Sweden
Notes: Used at Reci Göteborg oil treatment	Input	Refined resource	Degreasing agents	0.0001			m3	Technosphere	
Notes: Used at Reci Halmstad	Input	Refined resource	Degreasing agents	0.0557			l	Technosphere	
	Input	Refined resource	Diesel environmental class 1	0.43			kg	Technosphere	Sweden
	Input	Refined resource	Electricity	155.89			kWh	Technosphere	
	Input	Refined resource	Fuel oil	0.0426			m3	Technosphere	Sweden

Notes: 96 %	Input	Refined resource	H2SO4	0.0436			kg	Technosphere	
Notes: HCl (30%)	Input	Refined resource	HCl	0.248			kg	Technosphere	Sweden
	Input	Refined resource	Levoxin/Hydrazin			0.0001	kg	Technosphere	Sweden
Notes: No difference has been made between slaked lime and lime.	Input	Refined resource	Lime	0.282			kg	Technosphere	
	Input	Refined resource	Magnafloc LT 27 AG	0.0028			kg	Technosphere	
	Input	Refined resource	NaOH	2.726			kg	Technosphere	Sweden
	Input	Refined resource	Nitric acid	0.0294			kg	Technosphere	Sweden
	Input	Refined resource	Petrotec RI-54	0.0007			kg	Technosphere	Sweden
Notes: 75%	Input	Refined resource	Phosphoric acid	0.1982			kg	Technosphere	
	Input	Refined resource	PIX 111	1.5396			kg	Technosphere	Sweden
	Input	Refined resource	Polymers			0.0001	kg	Technosphere	Sweden
	Input	Refined resource	Sedipur Cf 104	0.0072			kg	Technosphere	Sweden
	Input	Refined resource	Sodiumhypoclorite	0.0041			l	Technosphere	Sweden
	Input	Refined resource	Thermal energy	3.818			kWh	Technosphere	
	Input	Refined resource	TMT 15	0.0004			kg	Technosphere	Sweden
	Input	Refined resource	Transformer oil	0.0568			l	Technosphere	Sweden
	Input	Refined resource	Trinatriumfosfat			0.0001	kg	Technosphere	Sweden
	Input	Refined resource	TUFF 100	0.0738			l	Technosphere	
Notes: Amount waste-oil entering the system to produce 1m3 of converted fuel oil	Input	Refined resource	Waste oil	1.4833			m3	Technosphere	
Notes: Since the fate of wastes leaving the system is outside the system boundary no difference between the wastes have been made. The wastes are only treated as an amount, measured in weight (1m3 is assumed to equal 1000 kg).	Output	By-product	Waste	3.948			kg	Technosphere	
	Output	Emission	Aluminium sulphate	0.03			kg	Ocean	Sweden
	Output	Emission	AOX	0.094			g	Ocean	Sweden
	Output	Emission	Aromatics	1.085			g	Ocean	Sweden
	Output	Emission	Ashes	11.722			g	Air	Sweden
	Output	Emission	Assay Al 204	0.048			kg	Ocean	Sweden
	Output	Emission	Cd	0.0001			g	Air	Sweden
	Output	Emission	Cd	0.0016			g	Ocean	Sweden
	Output	Emission	Cd	0.0184			mg	River	Sweden
	Output	Emission	Cl	32.074			g	River	Sweden
	Output	Emission	Cl	474.7			g	Ocean	Sweden
	Output	Emission	CO	48.13			g	Air	Sweden
	Output	Emission	CO2	155			kg	Air	Sweden
	Output	Emission	COD	1523.1			g	Ocean	Sweden
	Output	Emission	Cr	0.0001			g	Air	Sweden
	Output	Emission	Cr	0.036			g	Ocean	Sweden
	Output	Emission	Cu	0.0005			g	Air	Sweden
	Output	Emission	Dimetylaminoakrylat	0.007			kg	Ocean	Sweden

	Output	Emission	Dioxine			0.0001	mg	Air	Sweden
	Output	Emission	Dioxine			0.0001	mg	River	Sweden
	Output	Emission	Fe	210.9			g	Ocean	Sweden
	Output	Emission	H2SO4	0.0416			kg	Ocean	Sweden
	Output	Emission	HC	236			g	Air	Sweden
	Output	Emission	HCl	0.722			g	Air	Sweden
	Output	Emission	HCl	74.16			g	Ocean	Sweden
	Output	Emission	Hg	0.0003			g	Air	Sweden
	Output	Emission	Hg	0.0005			mg	River	Sweden
	Output	Emission	KOH	0.017			l	Ocean	Sweden
	Output	Emission	NaOH	0.0565			kg	Ocean	Sweden
	Output	Emission	Ni	0.0001			g	Air	Sweden
	Output	Emission	Ni	0.0164			mg	River	Sweden
	Output	Emission	Ni	0.787			g	Ocean	Sweden
	Output	Emission	Nitric acid	29.42			g	Ocean	Sweden
	Output	Emission	NOx	654			g	Air	Sweden
Notes: 100%	Output	Emission	NTA-solution	0.001			l	Ocean	Sweden
Notes: Oil contributed to oxygen demand.	Output	Emission	Oil	10.22			g	Ocean	
Notes: Oil contributes to ecotoxicological demand.	Output	Emission	Oil	12.273			g	Ocean	
	Output	Emission	Particles	64.17			g	Air	Sweden
	Output	Emission	Pb	0.003			g	Air	Sweden
	Output	Emission	Pb	0.0079			g	Ocean	Sweden
	Output	Emission	Pb	0.0118			mg	River	Sweden
	Output	Emission	Phenol	1.678			g	Ocean	Sweden
	Output	Emission	SO2	609			g	Air	Sweden
	Output	Emission	SO4	0.8535			g	River	Sweden
	Output	Emission	SO4	3.43			g	Ocean	Sweden
	Output	Emission	Sodiumgluconate	0.004			l	Ocean	Sweden
	Output	Emission	Sodiumhypoclorite	0.004			l	Ocean	Sweden
	Output	Emission	Sodiumkaprylaminodiproponate	0.009			l	Ocean	Sweden
	Output	Emission	Sulphid	0.056			g	Ocean	Sweden
Notes: Oxygen demand.	Output	Emission	Susp solids	0.036			g	River	
Notes: The suspended solids oxygen demand is already regarded in the measured COD for the subsystem.	Output	Emission	Susp solids	85.21			g	Ocean	
	Output	Emission	TEX (aliphatic)	7.231			g	Ocean	Sweden
	Output	Emission	Tridecylalkoholetoxilat	0.009			l	Ocean	Sweden
	Output	Emission	Zn	0.0075			g	Air	Sweden
	Output	Emission	Zn	0.1247			mg	River	Sweden
	Output	Emission	Zn	0.6498			g	Ocean	Sweden
	Output	Product	Converted fuel oil	1			m3	Technosphere	
	Output	Product	Electricity/Heat	0.0238			kWh	Technosphere	Sweden

About Inventory

Publication	
Intended User	
General Purpose	
Detailed Purpose	
Commissioner	
Practitioner	
Reviewer	
Applicability	
About Data	

Notes	

SPINE LCI dataset: Copper alloy casting of block metal from scrap

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper alloy casting of block metal from scrap
Functional Unit	1 kg block metal
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Scrap metal is transported, melted and cast into block metal.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	Average German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting and casting of block metal is 9.61 MJ/kg. Mainly fossil fuel heated furnaces are used for block metal production. For electricity a German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/kg for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. Only small amounts of water are used.

Flow Table and Specific Meta Data									
QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Output	By-product	Copper slag and fly ash	0.1			kg	Technosphere	
	Output	Emission	CO	0.34			g	Air	
	Output	Emission	CO2	0.59			kg	Air	
	Output	Emission	HC	0.15			g	Air	
	Output	Emission	NO2	0.69			g	Air	
	Output	Emission	Particles	0.34			g	Air	
	Output	Emission	SO2	0.04			g	Air	
	Output	Residue	Ashes	0.01			kg	Ground	
	Output	Residue	Gypsum	0			kg	Ground	

About Inventory	
Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	For production of block metal only different kinds of scrap are used. Nothing is said about the compositions in these scraps.

SPINE LCI dataset: Copper casting and drawing to 0.06mm wire

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper casting and drawing to 0.06mm wire
Functional Unit	1 kg 0,06 mm copper wire
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany

Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted (most often in gas fired furnaces type ASARCO), cast and formed to 8 mm wire. This wire is then transported again and drawn cold to a dimension of 0.06 mm.

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for copper wire 0.06 mm is 17.87 MJ/kg wire. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. 70 g per kg wire is recycled. Approximately 1 ml emulsion per kg produced material is needed and 10 g packaging material.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Output	By-product	Copper	0.07			kg	Technosphere	
	Output	Emission	CO	1.75			g	Air	
	Output	Emission	CO2	1.07			kg	Air	
	Output	Emission	HC	0.18			g	Air	
	Output	Emission	NO2	2.26			g	Air	
	Output	Emission	Particles	0.144			g	Air	
	Output	Emission	SO2	1.29			g	Air	
	Output	Residue	Ashes	0.04			kg	Ground	
	Output	Residue	Gypsum	0.013			kg	Ground	
	Output	Residue	Waste water	2			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments

Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added.

SPINE LCI dataset: Copper casting and drawing to 0.6mm wire

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper casting and drawing to 0.6mm wire
Functional Unit	1 kg of 0.6 mm copper wire
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted (most often in gas fired furnaces type ASARCO), cast and formed to 8 mm wire. This wire is then transported again and drawn cold to a dimension of 0.6 mm.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData	
Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German average industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for copper wire 0.6 mm is 8.04 MJ/kg wire. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. 70 g per kg wire is recycled. Approximately 1 ml emulsion per kg produced material is needed and 10 g packaging material.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Output	By-product	Copper	0.07			kg	Technosphere	
	Output	Emission	CO	1.68			g	Air	
	Output	Emission	CO2	0.39			kg	Air	
	Output	Emission	HC	0.15			g	Air	
	Output	Emission	NO2	1.17			g	Air	
	Output	Emission	Particles	0.084			g	Air	
	Output	Emission	SO2	0.52			g	Air	
	Output	Residue	Ashes	0.01			kg	Ground	
	Output	Residue	Gypsum	0.004			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory	
Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in wester Germany
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives.

SPINE LCI dataset: Copper casting and drawing to 8mm wire

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper casting and drawing to 8mm wire
Functional Unit	1 kg of 8mm copper wire
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted (most often in gas fired furnaces type ASARCO), cast and formed to 8 mm wire.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for copper wire 8 mm is 3.24 MJ/kg wire. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. 60 g per kg wire is recycled.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Output	By-product	Copper	0.06			kg	Technosphere	

	Output	Emission	CO	1.65			g	Air	
	Output	Emission	CO2	0.22			kg	Air	
	Output	Emission	HC	0.15			g	Air	
	Output	Emission	NO2	0.66			g	Air	
	Output	Emission	Particles	0.056			g	Air	
	Output	Emission	SO2	0.13			g	Air	
	Output	Residue	Ashes	0.005			kg	Ground	
	Output	Residue	Gypsum	0.002			kg	Ground	
	Output	Residue	Waste water	0.5			kg	Water	

About Inventory	
Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added.

SPINE LCI dataset: Copper casting, drawing and laquering to 0.6mm wire

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper casting, drawing and laquering to 0.6mm wire
Functional Unit	1 kg 0,6 mm laquer coated copper wire

Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted (most often in gas fired furnaces type ASARCO), cast and formed to 8 mm wire. This wire is then transported again and drawn cold to a dimension of 0.6 mm. The wire is then drawn through a laquer bath and a furnace at 550C.

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for laquered copper wire 0.6 mm is 8.45 MJ/kg wire. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. 70 g per kg wire is recycled. Approximately 1 ml emulsion per kg produced material is needed and 10 g packaging material. In addition 108 g laquer requiring another 14.67 MJ/kg wire is necessary. Values for the polymer are not included in the data table, but energy values are presented for different coating options in table 16 in the reference.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Output	By-product	Copper	0.07			kg	Technosphere	
	Output	Emission	CO	0			g	Air	
	Output	Emission	CO2	0.61			kg	Air	
	Output	Emission	HC	2.1			g	Air	
	Output	Emission	NO2	2.39			g	Air	
	Output	Emission	Particles	0.27			g	Air	
	Output	Emission	SO2	1.21			g	Air	
	Output	Residue	Ashes	0.01			kg	Ground	
	Output	Residue	Gypsum	0.004			kg	Ground	
	Output	Residue	Laquer residue	0.001			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. --

	Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added.Energy and emissions for polymer production also have to be included. In table 16 in the reference energies for producing different coating polymers are presented.

SPINE LCI dataset: Copper casting, drawing and polmer coating to 0.6mm wire

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper casting, drawing and polmer coating to 0.6mm wire
Functional Unit	1 kg 0,6 mm polymer coated copper wire
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted (most often in gas fired furnaces type ASARCO), cast and formed to 8 mm wire. This wire is then transported again and drawn cold to a dimension of 0.6 mm. The wire is then heated a put through an extruder to add the polymer.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given

Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for copper wire 0.6 mm is 11.35 MJ/kg wire. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. 70 g per kg wire is recycled. Approximately 1 ml emulsion per kg produced material is needed and 10 kg packaging material. In addition polymer is needed for the polymer coating. Values for the polymer are not included in the data table, but energy values are presented for different coating options in table 16 in the reference.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Output	By-product	Copper	0.07			kg	Technosphere	
	Output	Emission	CO	2.04			g	Air	
	Output	Emission	CO2	0.95			kg	Air	
	Output	Emission	HC	0.52			g	Air	
	Output	Emission	NO2	3.48			g	Air	
	Output	Emission	Particles	0.379			g	Air	
	Output	Emission	SO2	1.38			g	Air	
	Output	Residue	Ashes	0.001			kg	Ground	
	Output	Residue	Gypsum	0.004			kg	Ground	
	Output	Residue	Polymer residue	0.025			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. --- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	

Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. Energy and emissions for poymer production also have to be included. In table 16 in the reference energies for producing different coating polymers are presented.

SPINE LCI dataset: Copper continuous casting

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper continuous casting
Functional Unit	1 kg of cast copper
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace and cast continually into slabs or bars. Slags and dust are byproducts.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given

Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for continually cast copper is 3.95 MJ/kg slab or bar. Additional 0.9 MJ/kg product for transports of help materials and help equipment should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Output	By-product	Copper slag and dust	0.01			kg	Technosphere	
	Output	Emission	CO	0.67			g	Air	
	Output	Emission	CO2	0.29			kg	Air	
	Output	Emission	HC	0			g	Air	
	Output	Emission	NO2	0.99			g	Air	
	Output	Emission	Particles	0.1			g	Air	
	Output	Emission	SO2	0.36			g	Air	
	Output	Residue	Ashes	0.01			kg	Ground	
	Output	Residue	Gypsum	0.003			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added.

SPINE LCI dataset: Copper extrusion and drawing to profiles

Administrative

Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System

Name	Copper extrusion and drawing to profiles
Functional Unit	1 kg extruded copper profiles
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted (most often in gas fired furnaces type ASARCO), cast and formed to rods, which after heating to 900C are extruded and drawn to 50x10 mm profiles. Finally the profiles are annealed. Recyclate and coppercontaining sludge is produced as byproducts.

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	Average German industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for copper profiles is 8.41-10.51 MJ/kg profile. The variation depends on the casting procedure. Melting in a induction furnace followed by semicontinuous casting requires 4.31 MJ/kg, continuous casting 3.95 MJ/kg, while melting in a gas heated ASARCO furnace followed by continuous casting requires 1.54 MJ/kg. Additional 0.5 MJ/kg product for transports of help materials and transports within the companies should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. Approximately 7g oil, 2 g emulsions, 1 g H2SO4, 2 g NaOH and 10 g packaging material is needed for the forming processes.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Output	By-product	Copper	0.46			kg	Technosphere	
	Output	By-product	Coppercontaining sludge	0.01			kg	Technosphere	
	Output	Emission	CO	2.22			g	Air	
	Output	Emission	CO2	0.52			kg	Air	
	Output	Emission	HC	0.17			g	Air	

	Output	Emission	NO2	1.86			g	Air	
	Output	Emission	Particles	0.108			g	Air	
	Output	Emission	SO2	0.83			g	Air	
	Output	Residue	Ashes	0.02			kg	Ground	
	Output	Residue	Gypsum	0.009			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory	
Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung M.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives.

SPINE LCI dataset: Copper extrusion and drawing to tubes

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper extrusion and drawing to tubes
Functional Unit	1 kg of extruded and drawn copper tubes
Functional Unit Explanation	
Process Type	Gate to gate

Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted (most often in gas fired furnaces type ASARCO), cast and formed to rods, which after heating to 900C are drawn over a core to tubes with 15 mm diameter and 1mm thickness. Finally the tubes are annealed. Recyclate and coppercontaining sludge is produced as byproducts.

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for copper tubes is 13.02 MJ/kg tube. Additional 0.5 MJ/kg product for transports of help materials and transports within the companies should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. Approximately 7g oil, 2 g emulsions, 1 g H2SO4, 2 g NaOH and 10 g packaging material is needed for the formning processes.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	By-product	Copper	0.58			kg	Technosphere	
	Output	By-product	Coppercontaining sludge	0.01			kg	Technosphere	
	Output	Emission	CO	2.4			g	Air	
	Output	Emission	CO2	0.83			kg	Air	
	Output	Emission	HC	0.18			g	Air	
	Output	Emission	NO2	2.4			g	Air	
	Output	Emission	Particles	0.13			g	Air	
	Output	Emission	SO2	1.11			g	Air	
	Output	Residue	Ashes	0.03			kg	Ground	
	Output	Residue	Gypsum	0.012			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. --- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---

Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added..

SPINE LCI dataset: Copper ore concentrate preparation and delivery

Administrative	
Finished	Y
Date Completed	1998
Copyright	The International Copper Association
Availability	Public

Technical System	
Name	Copper ore concentrate preparation and delivery
Functional Unit	1 kg of ore concentrate
Functional Unit Explanation	The material leave this system as ore concentrate.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	Data received for this study are based on pyrometallurgical operations only. This activity includes 1) Copper ore mining and 2) Copper ore concentrate preparation and delivery. Production and use of electricity and fuel used in the processes are included. Below is a description of the included operations. -- 1) Ore mining -- The copper ore mining method used is determined by the size, shape and depth below the surface of the ore body. Most copper ores are mined by open pit mining in which large quarries are opened, the ore broken away from the deposits by use of explosives and shovelled into trucks. Actual energy requirements vary widely depending on the characteristics of the mine and ore handling techniques used. The type and the amount of ore deposit and the overlying rock and dirt and the depth of the seam below the surface, affect the level of energy needed for mining the ore.

	The data for copper mining have been received from three mining companies. The data cover the mining of 45 million tonnes of ore. -- 2) Ore concentrate preparation and delivery -- It is normal practice for mining companies to prepare or concentrate before shipping to reduce the amount of material to be transported. The data mainly relates to transportation of ore concentrate by rail and sea. Transporting the concentrate by sea is extensive. It is assumed that average shipping and rail transport distances were 10 000 km and 500 km respectively. The data cover the preparation of 2 million tonnes of concentrate.

System Boundaries

Nature Boundary	Some of the data on air and water emissions was provided in a form which made it impractical to calculate emissions for unit mass of product output. For example, from an air emission value given in the units of mg/m3 of air, it is not possible to calculate the total emission unless the total volume of air is known and this is seldom measured in pactice. Therefor, where available, only emission values associated with the given amount of product made are used.
Time Boundary	The data comes from mining companies for the operations during the 12 month period in 1995 (information why the year 1995 was chosen is not available).
Geographical Boundary	The data comes mainly from European operations. Further information of the geographical boundaries is not available.
Other Boundaries	The copper producing industry is international.
Allocations	The first thing that has been done to analyse this system is to break down the complex system into a series of separate sub-systems each of which produces a single product but which, when added together, exhibit the same charateristics as the original single system. In this study has co-product allocation and Stoichiometric allocation been applied. It is not often that practical processes exactly match for example the stoichiometric rules and an alternative method using mass must be applied.
Systems Expansions	Not applied

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, unspecified
Represents	German copper industry
Method	An LCA calculation of the ore concentrate preparation and delivery. The tables that have been used are the tables 34, 36, 37, 38 and 39 in the Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998. For the following subjects has a slightly different name been use here in SPINE compaired from the original tables in the IAC report: In SPINE: In the IAC report: Iron Ore Iron Natural Gas Gas/Condensate NaCl Sodium Chloride HC Hydrocarbons CH4 Methane Cu Cu++/Cu+++ Calcium Ca++ NO3-N NO3- Hazardous waste Regulated chemical
Literature Reference	Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998.
Notes	The total primary energy required for copper tubes is 13.02 MJ/kg tube. Additional 0.5 MJ/kg product for transports of help materials and transports within the companies should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. Approximately 7g oil, 2 g emulsions, 1 g H2SO4, 2 g NaOH and 10 g packaging material is needed for the formning processes.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Bauxite	20000			mg	Ground	
	Input	Natural resource	Bentonite	50			mg	Ground	
	Input	Natural resource	Calcium sulphate	1100			mg	Ground	
	Input	Natural resource	Coal	715000			mg	Ground	
	Input	Natural resource	Crude oil	150000			mg	Ground	
	Input	Natural resource	Dolomite	810			mg	Ground	

	Input	Natural resource	Iron ore	67000			mg	Ground	
	Input	Natural resource	Lead	2			mg	Ground	
	Input	Natural resource	Lignite	4500			mg	Ground	
	Input	Natural resource	Limestone	62000			mg	Ground	
	Input	Natural resource	NaCl	1000			mg	Ground	
	Input	Natural resource	Natural gas	53000			mg	Ground	
	Input	Natural resource	Nitrogen	420			mg	Ground	
Notes: Includes bonded and elemental sulphur.	Input	Natural resource	Sulphur	355			mg	Ground	
	Input	Natural resource	Wood	44000			mg	Ground	
	Input	Natural resource	Zinc	870			mg	Ground	
	Output	Emission	BOD	490			mg	Water	
	Output	Emission	Calcium	330			mg	Water	
	Output	Emission	CH4	820			mg	Air	
	Output	Emission	Cl	230000			mg	Water	
	Output	Emission	CO	4400			mg	Air	
	Output	Emission	CO2	2500000			mg	Air	
	Output	Emission	COD	1100			mg	Water	
	Output	Emission	Cu	22			mg	Air	
	Output	Emission	Cu	9			mg	Water	
	Output	Emission	Dissolved solids	520000			mg	Water	
	Output	Emission	HC	2600			mg	Air	
	Output	Emission	HC	6			mg	Water	
	Output	Emission	HCl	350			mg	Air	
	Output	Emission	HF	17			mg	Air	
	Output	Emission	NH4	16			mg	Water	
	Output	Emission	NO3-N	130			mg	Water	
	Output	Emission	NOx	24000			mg	Air	
	Output	Emission	Pb	1200			mg	Air	
	Output	Emission	Pb	18			mg	Water	
	Output	Emission	SO4	90000			mg	Water	
	Output	Emission	SOx	25000			mg	Air	
	Output	Emission	Sulphur	880			mg	Water	
	Output	Emission	Susp solids	19000			mg	Water	
	Output	Product	copper ore concentrate	1			kg	Technosphere	
	Output	Residue	Ashes	71000			mg	Technosphere	
	Output	Residue	Hazardous waste	11			mg	Technosphere	
	Output	Residue	Industrial waste	3400			mg	Technosphere	
	Output	Residue	Mineral waste	78000000			mg	Technosphere	

About Inventory

Publication	Ecoprofile of Primary Copper Production- A report for The International Copper Association By Dr. I. Boustead. 1998. -- Data documented by: Sofia Medin, Electrolux ESD Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose of this work was to produce life-cycle inventory data for the production of primary copper and the sub-processes based on data submitted by members of the International Copper Association from their own operations.
Detailed Purpose	The aim is to provide ''cradle to gate'' data for the ore concentrate preparation and delivery, which is a sub-process in the production of primary copper.
Commissioner	- The International Copper Association .
Practitioner	Boustead, Ian Dr - .

Reviewer	
Applicability	There is no recommendation of how to use the data from this report. This activity is part of a ''cradle to gate'' system for primary copper production. In the sequence of operations leading up to primary copper production there are six main stages involved. These are 1) Copper ore mining; 2) Copper ore concentrate preparation and delivery; 3) Production of matte copper; 4) Production of blister copper; 5) Production of copper anodes and 6) Production of primary copper. This activity only covers the stages 1) copper ore mining and 2) copper ore concentrate preparation and delivery. All six stages in the primary copper production have been described cumulatively in separate activities in the database
About Data	The data used for electricity and fuel production in the calculations leading to the results reported comes from the reports of International Energy Agency. Data Assumptions: Data received from participating companies show sometime wide variation with respect to metal contents of ore and various intermediate products such as concentrates, gas dust and scrap. Therefor has the following assumptions been made: 1. Copper content in ore. Where actual data on copper content of the ore were available these were used. Otherwise the content was calculated on the basis of mass flow. 2. There is also some loss of copper during ore preperation and the smelting and recovery processes. The loss can be calculated from the mass flow if accurate contents of the input and output materials where known.Where this is not possible, the loss is assumed to be 1% at each step of the sequence of operations. It is further assumed that there is another 4% loss of copper during the operational steps from ore preperation to electro-refining, making the total loss of copper to 5%.
Notes	The results in the report of the Ecoprofile study has been broken down into a number of categories, identifying the type of operation that gives rise to them. The categories are: 1. Fuel production 2. Fuel use 3. Process 4. Transport 5. Biomass (inputs and outputs associated with the use of biological materials such as wood).

SPINE LCI dataset: Copper ore mining

Administrative	
Finished	Y
Date Completed	1998
Copyright	The International Copper Association
Availability	Public

Technical System	
Name	Copper ore mining
Functional Unit	1 kg of copper ore
Functional Unit Explanation	The metal is leaving this system as copper ore.
Process Type	Cradle to gate
Site	Europe
Sector	Metal and mineral mining
Owner	Europe
Technical system description	Data received for this study are based on pyrometallurgical operations only. This activity covers copper ore mining. Production and use of electricity and fuel used in the process are included.

	The mining method used is determined by the size, shape and depth below the surface of the ore body. Most copper ores are mined by open pit mining in which large quarries are opened, the ore broken away from the deposits by use of explosives and shovelled into trucks. Actual energy requirements vary widely depending on the characteristics of the mine and ore handling techniques used. The type and the amount of ore deposit and the overlying rock and dirt and the depth of the seam below the surface, affect the level of energy needed for mining the ore. The data for copper mining have been received from three mining companies. The data cover the mining of 45 million tonnes of ore.

System Boundaries

Nature Boundary	Some of the data on air and water emissions was provided in a form which made it impractical to calculate emissions for unit mass of product output. For example, from an air emission value given in the units of mg/m3 of air, it is not possible to calculate the total emission unless the total volume of air is known and this is seldom measured in pactice.Therefor, where available, only emission values associated with the given amount of product made are used.
Time Boundary	The data comes from mining companies for the operations during the 12 month period in 1995 (information why the year 1995 was chosen is not available).
Geographical Boundary	The data comes mainly from European operations. Futher information of the geographical boundaries is not available.
Other Boundaries	The copper producing industry is international.
Allocations	The first thing that has been done to analyse this system is to break down the complex system into a series of separate sub-systems each of which produces a single product but which, when added together, exhibit the same charateristics as the original single system. In this study has co-product allocation and Stoichiometric allocation been applied. It is not often that practical processes exactly match for example the stoichiometric rules and an alternative method using mass must be applied.
Systems Expansions	Not applied

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, unspecified
Represents	German copper industry
Method	An LCA calculation of mining of copper ore. The tables that have been used are the tables 16, 18, 19, 20 and 21 in the Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998. For the following subjects has a slightly different name been use here in SPINE compaired from the original tables in the IAC report: In SPINE: In the IAC report: Iron Ore Iron Natural Gas Gas/Condensate NaCl Sodium Chloride HC Hydrocarbons CH4 Methane Calcium Ca++
Literature Reference	Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998.
Notes	The total primary energy required for copper tubes is 13.02 MJ/kg tube. Additional 0.5 MJ/kg product for transports of help materials and transports within the companies should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. Approximately 7g oil, 2 g emulsions, 1 g H2SO4, 2 g NaOH and 10 g packaging material is needed for the formning processes.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Bauxite	35000			mg	Ground	
	Input	Natural resource	Bentonite	16			mg	Ground	
	Input	Natural resource	Calcium sulphate	200			mg	Ground	
	Input	Natural resource	Coal	327800			mg	Ground	
	Input	Natural resource	Crude oil	110000			mg	Ground	
	Input	Natural resource	Dolomite	260			mg	Ground	

	Input	Natural resource	Iron ore	21000			mg	Ground	
	Input	Natural resource	Lignite	260			mg	Ground	
	Input	Natural resource	Limestone	16000			mg	Ground	
	Input	Natural resource	NaCl	940			mg	Ground	
	Input	Natural resource	Natural gas	19000			mg	Ground	
	Input	Natural resource	Nitrogen	720			mg	Ground	
	Input	Natural resource	Olivine	200			mg	Ground	
Notes: Includes bonded and elemental sulphur.	Input	Natural resource	Sulphur	430			mg	Ground	
	Input	Natural resource	Wood	37000			mg	Ground	
	Output	Emission	BOD	5			mg	Water	
	Output	Emission	Calcium	59			mg	Water	
	Output	Emission	CH4	710			mg	Air	
	Output	Emission	Cl	79			mg	Water	
	Output	Emission	CO	2000			mg	Air	
	Output	Emission	CO2	1200000			mg	Air	
	Output	Emission	COD	7			mg	Water	
	Output	Emission	Dissolved solids	12			mg	Water	
	Output	Emission	HC	470			mg	Air	
	Output	Emission	HC	5			mg	Water	
	Output	Emission	HCl	160			mg	Air	
	Output	Emission	HF	8			mg	Air	
	Output	Emission	NOx	33000			mg	Air	
	Output	Emission	Pb	220			mg	Air	
	Output	Emission	SO4	190			mg	Water	
	Output	Emission	SOx	12000			mg	Air	
	Output	Emission	Susp solids	5500			mg	Water	
	Output	Product	Copper ore	1			kg	Technosphere	
	Output	Residue	Ashes	35000			mg	Technosphere	
	Output	Residue	Industrial waste	940			mg	Technosphere	
	Output	Residue	Mineral waste	86000000			mg	Technosphere	

About Inventory

Publication	Ecoprofile of Primary Copper Production- A report for The International Copper Association By Dr. I. Boustead. 1998. -- Data documented by: Sofia Medin, Electrolux ESD Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose of this work was to produce life-cycle inventory data for the production of primary copper and the sub-processes based on data submitted by members of the International Copper Association from their own operations.
Detailed Purpose	The aim is to provide ''cradle to gate'' data for copper ore mining, which is a sub-process in the production of primary copper.
Commissioner	- The International Copper Association .
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	There is no recommendation of how to use the data from this report. This activity is part of a ''cradle to gate'' system for primary copper production. In the sequence of operations leading up to primary copper production there are six main stages involved. These are 1) Copper ore mining; 2) Copper ore concentrate preparation and delivery; 3) Production of matte copper; 4) Production of blister copper; 5) Production of copper anodes and 6) Production of primary copper. It is important to notice that the differnent parts are all cumulative.

	This activity only covers stage 1) copper ore mining. All six stages in the primary copper production have been described cumulatively in separate activities in the database.
About Data	The data used for electricity and fuel production in the calculations leading to the results reported comes from the reports of International Energy Agency. Data Assumptions: Data received from participating companies show sometime wide variation with respect to metal contents of ore and various intermediate products such as concentrates, gas dust and scrap. Therefor has the following assumption been made: 1. Copper content in ore. Where actual data on copper content of the ore were available these were used. Otherwise the content was calculated on the basis of mass flow.
Notes	The results in the report of the Ecoprofile study has been broken down into a number of categories, identifying the type of operation that gives rise to them. The categories are: 1. Fuel production 2. Fuel use 3. Process 4. Transport 5. Biomass (inputs and outputs associated with the use of biological materials such as wood)

SPINE LCI dataset: Copper ore mining and concentration

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper ore mining and concentration
Functional Unit	1 kg copper in concentrate
Functional Unit Explanation	
Process Type	Cradle to gate
Site	None
Sector	Metal and mineral mining
Owner	None
Technical system description	Copper ore concentrate is produced by mining in open pit or under ground mines and then treated to give a concentrate. These processes are usually in close connection to each other.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Mining from 4 unnamed countries representing 15% of the world production. Production of copper in Germany.
Other Boundaries	Not given

Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1992-1994
Data Type	Unspecified, expert outspoke
Represents	Average German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The values are an average (mine A 14.1%, mine B 24%, mine C 52.6%, mine D 9.2%) of the data for two open-pit and two under ground pits which represent 15% of the world production of copper. The average Cu concentration in those mines is 1,4. The energy use for a number of help materials is included. The total energy use for mining and concentration is 35 MJ (in primary energy as stated in the publication). 10% of the energy used is for the over sea transport. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. 1/3 of the primary energy is consumed in mining and 2/3 in concentration. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. In two of the mines 0.03 tons of molybdenum concentrate per ton of copper concentrate is also produced. The copper concentrates contain small amounts of precious metals. Water which is used in the process is to a large extent recycled. Only water losses are given under water use in the data sheet.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	Emission	CO	7.27			g	Air	
	Output	Emission	CO2	2.69			kg	Air	
	Output	Emission	HC	3.33			g	Air	
	Output	Emission	NO2	14.5			g	Air	
	Output	Emission	Particles	89.7			g	Air	
	Output	Emission	SO2	3.24			g	Air	
	Output	Residue	Ashes	80.1			g	Ground	
	Output	Residue	Gypsum	30.6			g	Ground	
	Output	Residue	Industrial waste	162			kg	Ground	
	Output	Residue	Rock	92.7			kg	Ground	
	Output	Residue	Waste water	70.3			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life Cycle Assessments
General Purpose	Increase knowledge about environmental impacts from copper inustry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	

Notes	

SPINE LCI dataset: Copper production

Administrative	
Finished	Y
Date Completed	1996-05-01
Copyright	
Availability	AUTORIZATIONS AND SECRECY: Public

Technical System	
Name	Copper production
Functional Unit	kg
Functional Unit Explanation	Inventory result for production of 1 kg copper.
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	BRIEF DESCRIPTION: The processes included in this activity are: Copper mining, concentration, calcination, electric furnace, converter and electrolysis. Ashes is dried and added in the electric furnace. Rich scrap (100% copper) is added in the converter. Other scrap is burned of combustibles in the Kaldofurnace, followed by melting, before it also is added in the converter. PROCESS DESCRIPTION: Copper ore mining The copper ore is mined in Aitik, Sweden, in an open pit mine. The explosives used in the mining are produced at, and transported 300 km by road from, Kimit AB in Kiirunavara, Sweden. Standard distance and modes of conveyance are assumed. The mined copper ore has a content of about 0,35%. Copper ore concentration The ore is concentrated in the ore dressing plant by crushing, grinding and floatation. The dressed ore is transported from the mine in Aitik, Sweden, to the Rönnskär Smelter in Boliden, Sweden for copper production. The distances and modes of conveyance are 20 km by road and 110 km by train. Calcination The ore concentrate is first calcinated in a fluidised bed roaster in 600-700 Celcius degrees. No external heating is required since the process is autogenius and uses heat released at the incineration of sulphur. The calcinated ore accompanies the process gas out of the roaster and is separated from the gas flow in a cyclone separator. Electric furnace The calcianated ore is transported (internally) to the electric furnace, where the material is melted at 1200 Celcius degrees. During the melting two layers are formed, the upper which is the molten slag and the lower which is the molten matte. The molten matte contains 47% copper. (The molten slag contains granite and small amounts of zink and lead. It is not included in this activity. It is transported to the slag refinery, where zink clinker and iron silicate is produced.). Converter

	The molten matte is transported (internally) from the electric furnace to the converter process. In the converter, the copper sulphide is converted to metallic copper in two steps. The concentration of copper after the converter is 98-99% and the formed blister copper is casted to anodes, with a weight of about 330 kg by a piece. To this process step both rich and other scrap are added. Electrolyses The electrolyses is the most time consuming process. It takes 20 days for the anodes to dissolve. The anodes are placed in electrolyses tanks with thin copper plates in between. These thin copper plates serve as cathodes and the pure copper is deposited on them. Two sets of cathode copper, weighing about 145 kg, are formed during the 20 days. The copper has now a purity of 99,95%. The anode remains are returned to the converters, where they are used as cooling scrap. Other scrap is burned of combustibles in the Kaldofurnace, followed by melting, before it is added in the converter.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Emissions to air and water, waste and natural resources.
Time Boundary	LIFETIME/APPLICABLE TIME OF SYSTEM/PRODUCT: The data is collected during the early nineties and one should consider that some change in process steps etc. may be done as times go.
Geographical Boundary	GEOGRAPHICAL EXTENSION (for large technical systems) All process steps is situated in Sweden, except for some (about 30%) of the virgin material, which is bought on the open market.
Other Boundaries	NOTES OF RELEVANT INCLUDED FUNCTIONS: Ashes In this study it is assumed that the ashes contain 10% copper. The other 90% is assumed to consist of other useful metals. The secondary ashes are treated as an inflow not traced back to the cradle. Rich scrap Rich scrap is treated as an inflow not traced back to the cradle.
Allocations	PRINCIPLE APPLIED: The allocations in this study is based on massflow (se NOTE further down). DESCRIPTION: Copper production The data for copper production is taken from an environmental report where the production lines are not fully seperated. A seperation has therefore been done between the lines, by using the overall mass balance in the environmental report. In this mass balance all inflows and outflows are specified concerning their contents of the metals Cu, Pb, Zn, Cd, As and Hg. The only metal not specified is Ni. All nickel emissions are allocated to the copper production. NOTE The report, from which this data is taken, has an ambiguity in which allocation method that is used for the copper production process step. It is difficult to say if the allocation is based on massflow or on economical basis. Drying The environmental loadings of ashes are allocated to the copper production by mass, since there is no information of the content of the other 90%. Other scrap The copper content in the other scrap is assumed to be 35,3% and therefor 35,3% of the emissions and energy need is allocated to the copper production. This mass allocation is chosen since there are no information available on the contents of the other 64,7% of the scrap.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	1996-05-01
Data Type	Derived, unspecified
Represents	Average German copper industry
Method	Taken from table 15 in Sunér M. Life Cycle Assessment of Aluminium, Copper and Steel.
Literature Reference	Life Cycle Assessment of Aluminium, Copper and Steel; Maria Sunér; Technical Environmental Planning; Report 1996:6; Chalmers University of Technology; Gothenburg; Sweden
Notes	The values are an average (mine A 14.1%, mine B 24%, mine C 52.6%, mine D 9.2%) of the data for two open-pit and two under ground pits which represent 15% of the world production of copper. The average Cu concentration in those mines is 1,4. The energy use for a number of help materials is included. The total energy use for mining and concentration is 35 MJ (in primary energy as stated in the publication). 10% of the energy used is for the over sea transport. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. 1/3 of the primary energy is consumed in mining and 2/3 in concentration. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. In two of the mines 0.03 tons of molybdenum concentrate per ton of copper concentrate is also produced. The copper concentrates contain small amounts of precious metals. Water which is used in the process is to a large extent recycled. Only water losses are given under water use in the data sheet.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Bauxite	24.8			g	Other	
	Input	Natural resource	Chalice	265			g	Other	
Notes: Resource for electricity production.	Input	Natural resource	Coal	68			g	Other	
	Input	Natural resource	Cu	863			g	Other	
	Input	Natural resource	Dolomite	0.107			g	Other	
	Input	Natural resource	Feldspar	79.6			mg	Other	
Notes: Hydro power. Resource for electricity production.	Input	Natural resource	Hydro power	16			g	Other	
	Input	Natural resource	Lime	0.153			g	Other	
	Input	Natural resource	Limestone	4.45			g	Other	
Notes: 7,07 g is resource for electricity production, 22,4 g is energy resources (excluding electricity production) and 6,28 g is energy resource for precombustion.	Input	Natural resource	Natural gas	107.05			g	Ground	
Method: The total oil consumption for the converter process is assumed by Boliden AB to be 708 m3 Eo1/year and the other scrap production is assumed to be 2000 m3 Eo1/year. Notes: 43,2 g is resource for electricity production, 149 g is energy resources (excluding electricity production) and 8,04 g is energy resource for precombustion.	Input	Natural resource	Oil	210.26			g	Other	
Notes: Resource for electricity production.	Input	Natural resource	Peat	15.4			g	Other	
	Input	Natural resource	Sand	0.879			g	Other	
	Input	Natural resource	Sodium sulphate	2.8			g	Other	
Notes: Resource for electricity production.	Input	Natural resource	Uranium ore	19.9			mg	Other	
	Input	Natural resource	Water	6110			g	Other	
Notes: Energy resource for precombustion.	Input	Refined resource	Diesel	1.27			g	Technosphere	
Notes: Energy resource for precombustion.	Input	Refined resource	Electricity	2.01			MJ	Technosphere	

Notes: An inflow not traced back to the cradle.	Input	Refined resource	Emulsifier	1.73			g	Technosphere	
Notes: An inflow not traced back to the cradle.	Input	Refined resource	Metal dust	56.4			g	Technosphere	
	Input	Refined resource	Portland soda	0.126			g	Technosphere	
Notes: Resource for electricity production.	Input	Refined resource	Renewable energy source	85	0		g	Technosphere	
Notes: 110 g is rich scrap-copper and 7,34 g is other scrap-copper. An inflow not traced back to the cradle.	Input	Refined resource	Scrap-copper	117.34			g	Technosphere	
	Input	Refined resource	Solvey soda	0.126			g	Technosphere	
	Output	Emission	Aldehydes	51.1			ug	Air	
	Output	Emission	As	4.08			mg	Air	
	Output	Emission	As	7.78			mg	Water	
	Output	Emission	BOD	2.9			ug	Water	
	Output	Emission	Cd	0.35			mg	Water	
	Output	Emission	Cd	7.81			mg	Air	
Notes: 5,03 mg is emitted to air from the electricity production.	Output	Emission	CH4	0.39			g	Air	
	Output	Emission	Cl	0.134			mg	Air	
	Output	Emission	Cl	0.329			ug	Water	
Notes: 82,6 mg is emitted to air from the electricity production.	Output	Emission	CO	1.75			g	Air	
Method: Carbon dioxide emissions are calculated at the Kaldo furnece from the oil consumption. Notes: 145 g is emitted to air from the electricity production.	Output	Emission	CO2	746			g	Air	
Notes: 9,09 ug is emitted to water from the electricity production.	Output	Emission	COD	0.932			mg	Water	
	Output	Emission	Cr	7.54			ng	Air	
	Output	Emission	Cu	32.2			mg	Air	
	Output	Emission	Cu	6.87			mg	Water	
	Output	Emission	Dioxine	0.124			ng	Air	
Notes: 26,2 ug is F-ions and 58,3 ng is Fe.	Output	Emission	Fe	26.3			ug	Water	
Notes: 0,196 ug is emitted to air from the electricity production.	Output	Emission	Fluoride	34.9			ug	Air	
Notes: 79,5 mg is emitted to air from the electricity production.	Output	Emission	HC	1.24			g	Air	
	Output	Emission	Hg	0.195			mg	Water	
	Output	Emission	Hg	39.2			ug	Air	
Notes: 16,5 mg is emitted to air from the electricity production.	Output	Emission	N2O	42.3			mg	Air	
	Output	Emission	Na	4.31			ug	Water	
	Output	Emission	NaCl	13.3			mg	Water	
Notes: 12,1 ug is emitted to water from the electricity production.	Output	Emission	NH3	2.21			mg	Water	
Notes: 10,1 ug is emitted to air from the electricity production.	Output	Emission	NH3	50			mg	Air	
	Output	Emission	NH4-N	0.207			g	Water	
	Output	Emission	NH4NO3	0.309			g	Water	
	Output	Emission	NH4NO3	84.3			mg	Air	
	Output	Emission	Ni	9.73			mg	Water	
Notes: 6,16 ug is emitted to water from the electricity production.	Output	Emission	NO3-N	0.232			g	Water	
Notes: 0,355 g is emitted to air from the electricity production.	Output	Emission	NOx	8.33			g	Air	
Notes: 53,9 ng is emitted to water from the electricity production.	Output	Emission	N-tot	66.6			mg	Water	
Notes: 94,5 ug is emitted to water from the electricity production.	Output	Emission	Oil	2.57			mg	Water	
Notes: 6,47 mg is emitted to air from the electricity production.	Output	Emission	Particulates	1.01			g	Air	
	Output	Emission	Pb	0.516			mg	Water	
	Output	Emission	Pb	37.6			mg	Air	
Notes: 1,60 ng is emitted to water from the electricity production.	Output	Emission	Phenol	34.8			ug	Water	

Notes: 0,291 g is emitted to air from the electricity production.	Output	Emission	SO2	16.5			g	Air	
	Output	Emission	SO4	5.53			ug	Water	
	Output	Emission	SOx	60.2			mg	Air	
Notes: 2,90 ug is emitted to water from the electricity production.	Output	Emission	Susp solids	73.9			ug	Water	
	Output	Emission	Zn	20.1			mg	Water	
	Output	Emission	Zn	5.71			mg	Air	
	Output	Residue	Aldehydes	0.964			g	Other	
	Output	Residue	Ashes	0.732			mg	Other	
Notes: The waste comes from the electricity production.	Output	Residue	Highly active rad ac waste	29.8			ug	Other	
Notes: The waste comes from the electricity production.	Output	Residue	Medium active rad ac waste	0.159			mg	Other	
Notes: Landfill waste: sand 245 kg granite 186 kg margine ore 28,5 kg.	Output	Residue	Mineral waste	460			kg	Landfill ground	
Notes: The waste comes from the electricity production.	Output	Residue	Radioactive waste	1.08			g	Other	
	Output	Residue	Redmud	17.2			g	Other	
	Output	Residue	Waste	35.1			g	Other	
Date concieved: 1996-05-01 Data type: Derived, unspecified Literature: Life Cycle Assessment of Aluminium, Copper and Steel; Maria Sunér; Chalmers University of Technology; Technical Environmental Planning; Report 1996:6; Göteborg; Sweden	Output	Residue	Waste containing explosives	0.539			g	Other	

About Inventory	
Publication	Life Cycle Assessment of Aluminium, Copper and Steel; Maria Sunér; Technical Environmental Planning; Report 1996:6; Chalmers University of Technology; Gothenburg; Sweden -- Data documented by: Maria Erixon, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Life Cycle Assessment-practiti
General Purpose	To make an LCA for Al, Cu and steel.
Detailed Purpose	The data is presented in the report Life Cycle Assessment of Aluminium, Copper and Steel. The purpose of the report was to collect and present inventory data on production and recycling of the three materials aluminium, copper and steel of higher quality than earlier published data.
Commissioner	
Practitioner	Sunér, Maria - Teknisk Miljöplanering Chalmers Tekniska Högskola 412 96 Göteborg Sweden.
Reviewer	
Applicability	CERTAIN CAUTIONS: Almost all data is site-specific and therefore it is not directly applicable in LCA:s requiring average data for metal production.
About Data	GENERAL DATA SOURCE DESCRIPTION: The metal emission to air from the processes Concentration, Calcination, Converter, Electrolyses and Drying are particle bonded, but it is not known if they are included in the parameter particulates. Copper ore concentration Rich scrap It is not known in what chemical form the metal emissions to water are emitted. Calcination It is assumed that there is no mass change in the calcination process, even though sulphur is emitted. Converter process

	The total oil consumption is assumed, together with Boliden AB, to be 708 m3 Eo1/year. Carbon dioxide emissions are calculated from the oil consumption. Electrolyses Assumed amounts of the secondary copper raw materials: Ashes 60% Rich scrap 12% Other scrap 28% Other scrap The total oil consumption is assumed to be 2000 m3 Eo1/year and carbon dioxide emissions are calculated at the Kaldo furnece from the oil consumption.
Notes	

SPINE LCI dataset: Copper rolling to strips

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper rolling to strips
Functional Unit	1 kg of rolled copper strip
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted (most often in gas fired furnaces type ASARCO), cast and formed to slabs, which after heating to 900C are rolled hot down to 11 mm. After cooling the strips are machined on both sides and cold rolled to strips 0.5x800 mm. Finally the strip coils are annealed. Recyclate and coppercontaining sludge is produced as byproducts.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995

Data Type	Unspecified, expert outspoke
Represents	German average industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for copper strips is 7.82-10.42 MJ/kg profile. The variation depends on the casting procedure. Melting in a induction furnace followed by semicontinuous casting requires 4.21 MJ/kg, continuous casting 3.95 MJ/kg, while melting in a gas heated ASARCO furnace followed by continuous casting requires 1.54 MJ/kg. Additional 0.5 MJ/kg product for transports of help materials and transports within the companies should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. Approximately 7g oil, 2 g emulsions, 1 g H2SO4, 2 g NaOH and 10 g packaging material is needed for the forming processes.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	By-product	Copper	0.31			kg	Technosphere	
	Output	By-product	Coppercontaining sludge	0.01			kg	Technosphere	
	Output	Emission	CO	2.01			g	Air	
	Output	Emission	CO2	0.59			kg	Air	
	Output	Emission	HC	0.04			g	Air	
	Output	Emission	NO2	1.89			g	Air	
	Output	Emission	Particles	0			g	Air	
	Output	Emission	SO2	0.79			g	Air	
	Output	Residue	Ashes	0.02			kg	Ground	
	Output	Residue	Gypsum	0.009			kg	Ground	
	Output	Residue	Waste water	4			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added.

SPINE LCI dataset: Copper skew rolling, pilgering and drawing to tubes

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Copper skew rolling, pilgering and drawing to tubes
Functional Unit	1 kg of pilgered copper tubes
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted (most often in gas fired furnaces type ASARCO), cast and formed to rods, which after heating to 900C are skew rolled, pilgered and drawn cold to tubes with 15 mm diameter and 1mm thickness. Finally the tubes are annealed. Recyclate and coppercontaining sludge is produced as byproducts.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	Average German industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for copper tubes is 8.0 MJ/kg tube. Additional 0.5 MJ/kg product for transports of help materials and transports within the companies should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. Approximately 7g oil, 2 g emulsions, 1 g H2SO4, 2 g NaOH and 10 g packaging material is needed for the forming processes.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	By-product	Copper	0.15			kg	Technosphere	
	Output	By-product	Coppercontaining sludge	0.01			kg	Technosphere	
	Output	Emission	CO	1.82			g	Air	
	Output	Emission	CO2	0.52			kg	Air	
	Output	Emission	HC	0.16			g	Air	
	Output	Emission	NO2	1.64			g	Air	
	Output	Emission	Particles	0.085			g	Air	
	Output	Emission	SO2	0.54			g	Air	
	Output	Residue	Ashes	0.02			kg	Ground	
	Output	Residue	Gypsum	0.006			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added.

SPINE LCI dataset: Cotton (conventional) fibres production. ESA-DBP

Administrative

Finished	Y
Date Completed	2004
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Cotton (conventional) fibres production. ESA-DBP
Functional Unit	1 kg of conventional cotton fibres
Functional Unit Explanation	Conventional cultivated cotton is of the annual type (the wild plant is perennial)
Process Type	Gate to gate
Site	Not applicable
Sector	Materials and components
Owner	Not applicable
Technical system description	Cultivated cotton is of the annual type, while the wild plant is perennial. The fibers are attached to the seeds in the seed ball (Wynne, 1997). This process is included in the report 'Methodological issues in the LCA procedure for the textile sector.' Link to report: http://cpmdatabase.cpm.chalmers.se/DataReferences /ESA_2004-7.pdf Other processes in the CPM Database also included in the above publication: 'Cotton covering of sofa. ESA-DBP', 'Flame retardant polyester (Trevira CS) covering of sofa. ESA-DBP' and 'Wool/polyamide covering of sofa. ESA-DBP'.

System Boundaries

Nature Boundary	''Cultivated cotton is of the annual type, while the wild plant is perennial. Cotton can be cultivated in a belt from 35o north to 30o south of the equator. The fibers are attached to the seeds in the seed ball (Wynne, 1997). China and the US produce together about 44% of the world supply (Ellebäk Laursen et al, 1997).''
Time Boundary	Unknown. The importer of data to CPMDatabase makes a qualified guess that the data is produced in the 1990s, based on the publication years of the literature references that are referred to in the report.
Geographical Boundary	''Cultivated cotton is of the annual type, while the wild plant is perennial. Cotton can be cultivated in a belt from 35o north to 30o south of the equator. The fibers are attached to the seeds in the seed ball (Wynne, 1997).'' According to Ellebäk Laursen et al (1997) the values globally may range according to the inventory data in the flow table.
Other Boundaries	Unknown.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	Unknown.
Data Type	Derived, mixed
Represents	According to Ellebäk Laursen et al (1997) the values, for cotton fibre production, globally may range according to this inventory data.
Method	quantity=arithmetic mean from min max values.
Literature Reference	Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences /ESA_2004-7.pdf
Notes	The data for the base case are within this data range (with the assumption that ''water consumption'' includes rainwater). There is no data for emissions of agrochemicals.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: includes rainwater	Input	Natural resource	Water	18000	7000	29000	l	Water	World
Notes: Value reliability questioned. Value as reported in reference. Data importer notes; it would be more reliable if the value ranged from 48 to 65 MJ (48-65 MJ), that would be along the same line of reporting as the other values.	Input	Refined resource	Energy (non-material)	48.65			MJ	Technosphere	World

	Input	Refined resource	Fertilizers	280	0	560	g	Technosphere	World
Notes: concentrations not known	Input	Refined resource	Herbicides	1.21	0.96	1.45	g	Technosphere	
Notes: concentrations not known	Input	Refined resource	Insecticides	0.42	0.01	0.83	g	Technosphere	
	Output	Product	cotton fibres	1			kg	Technosphere	
Notes: Depending on harvesting method.	Output	Residue	Solid waste from ginning	1.47	0.03	2.91	g	Technosphere	

About Inventory

Publication	Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2004-7.pdf
Intended User	LCA practitioners and textile interested parties.
General Purpose	Part of doctoral studies.
Detailed Purpose	The goal of this case study was to identify, map and discuss LCA related methodological issues in the textile sector. This was done through an LCA study, with the goal of ranking three fabrics types for a sofa.
Commissioner	Stiftelsen Svensk Textilforskning - .
Practitioner	Lisbeth Dahllöf - .
Reviewer	Maria Walenius Henriksson - IFP Research AB
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	''Inputs of fertilizers and pesticides were found on the home page of USDA (1999). Data were for Upland cotton, the main type according to the 2000 Crop Production Summary (2001). N, P2O5 and K2O were reported and they were translated to ammonium nitrate, diammonium phosphate and potassium nitrate since LCA data for these chemicals were known for Europe (methodological issue 15, Davis and Haglund 1999). The fertilizers reported are used in Texas (EPA 1999a) but potassium nitrate is the least common, only 0.7% of the potassium is from potassium nitrate. Inputs of pesticides were found from the USDA (1999). Desiccants and defoliation agents are probably included in ''other chemicals'' as well as chemicals for disease control. The herbicide Trifluralin was applied to 74% of the area and the insecticide Malathion was applied to 56% of the area.'' ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Importer of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Cotton covering of sofa. ESA-DBP

Administrative

Finished	Y
Date Completed	2004
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Cotton covering of sofa. ESA-DBP
Functional Unit	''The functional unit was: surface covering of a 3-seat sofa for private use during 10 years.'' For cotton fabric it is 4.99 kg per sofa.
Functional Unit Explanation	See 'Function'.
Process Type	Cradle to grave
Site	Not applicable
Sector	Consumer goods
Owner	Not applicable
Technical system description	The system is descibed in ''Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector - a case study concerning fabrics for a sofa. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden'': http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2004--7.pdf Other processes in the CPM Database also included in the above publication: 'Cotton (conventional) fibres production. ESA-DBP', 'Flame retardant polyester (Trevira CS) covering of sofa. ESA-DBP' and 'Wool/polyamide covering of sofa. ESA-DBP'. ''The function was to provide a surface covering for a sofa. The fiber type in this LCA was conventional cotton. The color of the fabric was red. Six laundry washings for the cotton fabric were assumed in order to see the relative environmental importance of the cleaning step. It was assumed that the fabric could be readily removed from the sofa. Incineration at disposal of the fabric used was assumed in the base case (the most probable life cycle chains). Heat recovery and emissions from the incineration were taken into account, but possible oil saving or replacement of other waste in the incinerator was only tested in the sensitivity analysis.'' ''Two Swedish weaving mills willing to participate in this study were found. In figure 2 in the ESA report 2004-7, typical production chains are shown.'' In the litterature reference following processes are included: - Cotton cultivation - Cotton ginning - Cotton baling - Truck driving in Texas - Freighter (cargo ship), large on the Atlantic - Truck from port to Swedish spinning factory - Rotor spinning of cotton - Truck from Swedish spinning plant to weaving plant - Weaving with sizing in Sweden - Travel at work from cotton weaving mills site - Truck from weaving mill to wet treatment plant - Wet treatment and dyeing of cotton fabric - Truck from Swedish wet treatment plant back to weaving mill - Textile distribution at weaving mills site in Sweden - Truck from Swedish weaving mill to upholstery plant - Upholstering of a sofa with cotton fabric - Truck from upholstery site to customer - Use of the sofa - Truck from user to incineration plant - Incineration of cotton fabric

System Boundaries

Nature Boundary	''Mineral resources and water were traced back to their reserves in nature and emissions were followed to air, water or soil. Below are the exceptions found, when the processes were not traced back to the nature reserves or water, or followed to air, water or ground. - A wastewater-treatment plant was included, but the decomposition of each individual chemical was not studied. - The production of the process chemicals and some packaging materials were not within the system boundaries.'' ''Cultivated cotton is of the annual type, while the wild plant is perennial. Cotton can be cultivated in a belt from 35o north to 30o south of the equator. The fibers are attached to the seeds in the seed ball (Wynne, 1997).''
Time Boundary	''Data were collected by interviews from 1999 to 2002, but data from reports ranged from 1993 to 1998. Most reports were from 1997.''
Geographical Boundary	''Cotton: *production of cotton fibers: Texas, USA *yarn production, weaving, wet treatment including dyeing of the fabric, upholstering, use and incineration: Sweden'' ''Cotton was assumed to be cultivated in Texas. The reason for this assumption was that the Swedish cotton spinner bought their cotton mainly from Texas. The US is the second largest

	cotton producer (after China) in the World. China and the US produce together about 44% of the world supply (Ellebäk Laursen et al, 1997).''
Other Boundaries	''The fabrics were assumed to not to be worn out before they were disposed of, a realistic scenario for Swedish conditions. Therefore the abrasion resistance was not taken into consideration in the study, while the effect of different lifetimes of the fabrics is discussed in chapter 4.3.7.'' ''Truck driving in Texas The distance was assumed to 300 km. This distance is assumed to be an average from the ginning plants to Houston. Medium truck (total weight: 24 tons, maximum load: 14 tons), fulfilling the ''Euro 1'' emission regulations (1993-1995), load factor 50% and rural driving mode were assumed.'' ''Freighter (cargo ship), large on the Atlantic The distance Houston-Gothenburg was estimated to 10,279 km. The cotton bales are in containers on freighters. The spinning company sets no demands regarding which fuel should be used by the freighter (Importer 2000). ''Truck from port to Swedish spinning factory The distance was assumed to about 80 km and medium truck (total weight: 24 tons, maximum load: 14 tons), fulfilling the ''Euro 2'' emission regulations (1996-), load factor 50% and rural driving mode were assumed.'' ''Rotor spinning of cotton The data were derived from a spinning and weaving mill (2000) for cotton. Comparisons were made with literature. The spinning mill did also weaving. - About cardboard and polypropylene: data come from another cotton weaving mill. They claim that cotton thread comes with one time use pallet (wood), which contains 9 boxes with 12 cones per box. One cone weights 65 g and contains 800 g thread. The cone was assumed to be made of polypropylene. The box is made of cardboard and has an estimated weight of 300 g. Note that in this study only the production of the polymers are included, not the plastic items. - Wood was included, but not the production of the pallet. - In the past, byssinosis, a respiratory disorder caused by dust from cotton and other fibers (Encyclopædia Britannica April 2003) was a problem associated with bale opening, but now the process has been automated, and the problem has disappeared. - Workers must wear ear protection. The noise level is 89-95 dB. There were no problems with impaired hearing among the workers. Therefore this was not reported. - Water is used for air conditioning. Here it was assumed to 0 since all water was allocated to the weaving activity, which was in the same mill. For this study this is not important, but it would have been better for the activities to share 50% of the water consumption each. - Personnel travel at work was not known, but was probably low and therefore not reported.'' ''Truck from Swedish spinning plant to weaving plant The distance was assumed to about 30 km.'' ''Weaving with sizing in Sweden Weaving includes warping, dressing, weaving and inspection.'' ''Truck from weaving mill to wet treatment plant The distance was assumed to 30 km.'' ''Wet treatment and dyeing of cotton fabric - Business trips are included, but both wet treatment mills claim there are hardly any business trips; therefore data were assumed to be 0. - Chemicals for the machines were included, but according to one wet treatment mill, the value is insignificant, therefore it was assumed to 0. - The fixation grade of the dyeing agents was reported from one wet treatment mill to be 75%. Where no concentration of the color is reported, a concentration of 50% was assumed. Perfluoric acids, fluor polymer emulsion and nonionic emulsifier were assumed to fixate at 100%. This gave a total of 16.33 g chemical loss/kg undyed fabrics.'' ''Truck from Swedish wet treatment plant back to weaving mill The distance was assumed to 30 km.'' ''Textile distribution at weaving mills site in Sweden Energy and water consumption was considered to be insignificant.'' ''Truck from Swedish weaving mill to upholstery plant The distance was assumed to 500 km.'' ''Upholstering of a sofa with cotton fabric - Energy used was derived from the working time. Two upholstery companies have answered that about 3 hours are used. Assumptions regarding sewing machines, heating and general electricity were made. - The fabric share of the general energy requirement for the production of a sofa was assumed to 25%.'' ''Use of the sofa It was assumed that the fabric is laundered six times during its lifetime. Data regarding chemical use came from Pulli (1997), where environmental impact of a cotton T-shirt was reported. For the fabrics it was assumed that the machine is filled to maximum and the ironing time is half the time of ironing a cotton T-shirt. Tumble-drying was included. It is

	not clear from the report which machine type was reported, but energy data combined with water consumption indicated an old machine, washing at 40 0C. '' ''Truck from user to incineration plant Light truck with maximum 14 tons weight, 50% load was assumed. The truck was assumed to be set according to the Euro2 emissions regulations. The distance was assumed to 50 km in urban area. Empty return was assumed; therefore the distance to the incineration plant was assumed to 25 km.'' ''Incineration of cotton fabric Heat recovery regards cotton fabric combustion (Ellebäk Laursen et al1997).''
Allocations	''Weaving with sizing in Sweden - Allocation: All energy and material was allocated to the fabrics without the spillage (thus considered to have zero value, although it can be used for furniture upholstery). - Data for water for sizing and moisture came from one cotton-weaving mill, and all water was allocated to the weaving mill. The amount that does not go to the wastewater-treatment plant is water that has evaporated. The water amount to wastewater-treatment plant was an estimate. In the original data, water was assumed to unknown type, but a realistic estimate is that industrial water was used, here set to drinking water.'' ''Textile distribution at weaving mills site in Sweden Allocation was only to dyed and finished fabric with packaging and not samples, except for input of packaging material, which was allocated to both samples and product.'' ''The allocation procedure by mass was not uniform in applications. The deviations were as follows: - No flows were allocated to waste, such as edge strips from weaving or cardboard or textile samples. - In the weaving operation, allocation was made per meter fabric. - Allocations for light fuel oil, heavy fuel oil, LPG and natural gas production were not known as well as for electricity from natural gas or oil and production of sodium hydroxide and ethylene glycol used for the sensitivity analysis. - For electricity production (Swedish average) the allocation between recycling and virgin materials was according to the 50/50 method. When heat was also produced, the allocation was according to energy output. - For electricity (European average), exergy values were used to allocate between electricity and heat.''
Systems Expansions	''In the life cycle of the cotton fabric, 10.1 kg cottonseed is also generated, but is not an output here because its benefit is calculated (system expansion).'' ''System expansion: 66% of the seed cotton is cotton seed, which gives oil, meal, hulls and linters (short fuzz fibers), which were treated by system expansion.'' ''Incineration of cotton fabric Only one aspect of system expansion is taken into consideration here: the heat recovery. The heat created was assumed to be used for e.g. district heating. If the incineration replaces oil combustion, the carbon dioxide emission would be negative and the SOx emission would be less, but if it replaces other waste, some methane emission would also have to be added in the table, since materials on landfills create methane. (The replacement of other waste can be approximated with the landfill of fabric scenario in the sensitivity analysis.)''

Flow Data

General Activity QMetaData

Date Conceived	Unknown
Data Type	Calculated
Represents	See 'Function'.
Method	The data is produced with the software tool LCAit.
Literature Reference	Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector - a case study concerning fabrics for a sofa. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se /CPMDatabase/DataReferences/ESA_2004-7.pdf
Notes	In the life cycle of the cotton fabric, 10.1 kg cottonseed is also generated, but is not an output here because its benefit is calculated (system expansion). This data set is generated with the software LCAit. All values that are below 0.001 kg and values given in the unit Bq are excluded. These values can be found in the litterature reference.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Acetic acid	0.451			kg	Technosphere	
	Input	Refined resource	AE	0.0639			kg	Technosphere	

	Notes: in water	Input	Refined resource	Alkylpolyethyleneglycolether	0.108			kg	Technosphere	
		Input	Refined resource	Ammonium nitrate	1.44			kg	Technosphere	
	Notes: Powder mixture.	Input	Refined resource	Azo-copper complex colorant	0.0039			kg	Technosphere	
	Notes: Powder mixture.	Input	Refined resource	Azo-reactive colorant	0.146			kg	Technosphere	
		Input	Refined resource	Cardboard	0.222			kg	Technosphere	
	Notes: Other Chemicals	Input	Refined resource	Chemicals	0.00361			kg	Technosphere	
		Input	Refined resource	CMC	0.00799			kg	Technosphere	
		Input	Refined resource	DAS-1	0.0016			kg	Technosphere	
		Input	Refined resource	Diammonium phosphate	0.194			kg	Technosphere	
		Input	Refined resource	Diazo colorant	0.0429			kg	Technosphere	
		Input	Refined resource	Enzyme	0.00398			kg	Technosphere	
	Notes: In solution.	Input	Refined resource	Enzyme	0.0156			kg	Technosphere	
		Input	Refined resource	Fat alcoholpolyclycolether	0.039			kg	Technosphere	
		Input	Refined resource	Fatty alcoholethoxylate	0.117			kg	Technosphere	
		Input	Refined resource	FeSO4	0.0615			kg	Technosphere	
		Input	Refined resource	Fluoric polymer emulsion	0.156			kg	Technosphere	
		Input	Refined resource	Herbicides	0.0139			kg	Technosphere	
		Input	Refined resource	Hydrogen peroxide	0.106			kg	Technosphere	
		Input	Refined resource	Insecticides	0.046			kg	Technosphere	
		Input	Refined resource	LAS	0.0798			kg	Technosphere	
		Input	Refined resource	Lime	0.00443			kg	Technosphere	
		Input	Refined resource	Lubricant oil	0.00000568			m3	Technosphere	
		Input	Refined resource	Magnesium chloride	0.0156			kg	Technosphere	
		Input	Refined resource	Methoxymethylated 4,5-dihyrdoxyethylurea	0.0273			kg	Technosphere	
		Input	Refined resource	Na carbonate	0.0798			kg	Technosphere	
		Input	Refined resource	Na perborate	0.12			kg	Technosphere	
		Input	Refined resource	Na sulphate	0.0982			kg	Technosphere	
		Input	Refined resource	Nonionic emulsifier	0.00557			kg	Technosphere	
	Notes: In water.	Input	Refined resource	Organic phosphorous compound	0.0357			kg	Technosphere	
		Input	Refined resource	Other fuel	10.2			MJ	Technosphere	
	Notes: Other supply materials	Input	Refined resource	Paper	0.0241			kg	Technosphere	
		Input	Refined resource	Paraffine mixture, anionic	0.0195			kg	Technosphere	
	Notes: In water solution.	Input	Refined resource	Perflouric acids	0.0.195			kg	Technosphere	
		Input	Refined resource	Phosphonate	0.00799			kg	Technosphere	
		Input	Refined resource	Phosphoric acid ester, anionic	0.0184			kg	Technosphere	
		Input	Refined resource	Polyacrylic and phosphoric acid derivate	0.0156			kg	Technosphere	
		Input	Refined resource	Polycarboxylate	0.024			kg	Technosphere	

	Input	Refined resource	Potassium nitrate	0.0986			kg	Technosphere	
Notes: In solution.	Input	Refined resource	Proteine derivate	0.0223			kg	Technosphere	
	Input	Refined resource	Soap	0.024			kg	Technosphere	
Notes: Anhydrous.	Input	Refined resource	Sodium carbonate	0.0646			kg	Technosphere	
	Input	Refined resource	Sodium chloride	0.0078			kg	Technosphere	
	Input	Refined resource	Sodium hydroxide	2.38			kg	Technosphere	
Notes: Sodium salt of highly sulphatized fatty acid	Input	Refined resource	Sodium salt	0.039			kg	Technosphere	
	Input	Refined resource	Sodium silicate	0.251			kg	Technosphere	
	Input	Refined resource	Starch	0.361			kg	Technosphere	
	Input	Refined resource	Sulphuric acid	0.00739			kg	Technosphere	
	Input	Refined resource	Surfactants with terpene hydrocarbons	0.0267			kg	Technosphere	
	Input	Refined resource	TAED	0.016			kg	Technosphere	
	Input	Refined resource	Water	1.69			kg	Technosphere	
	Input	Refined resource	Zeolite A	0.24			kg	Technosphere	
	Input	Resource	Agricultural land	108			m2 year	Ground	America
	Input	Resource	Bauxite	0.0267			kg	Ground	
	Input	Resource	Biomass	0.831			kg	Ground	
	Input	Resource	Crude oil	17			kg	Ground	
	Input	Resource	Hard coal	3.18			kg	Ground	
	Input	Resource	Hydro energy	161			MJ	Ground	
	Input	Resource	Iron in ore	0.00327			kg	Ground	
	Input	Resource	Iron ore	0.00126			kg	Ground	
	Input	Resource	Irrigation water	22600			kg	Water	
	Input	Resource	Lignite	0.271			kg	Ground	
	Input	Resource	Limestone	0.0438			kg	Ground	
	Input	Resource	Natural gas	0.698			kg	Ground	
	Input	Resource	Sodium chloride	0.0212			kg	Ground	
	Input	Resource	Unspecified fuel	0.0000255			MJ	Ground	
	Input	Resource	Uranium in ore	0.00124			kg	Ground	
Notes: Unspecified type of water.	Input	Resource	Water	1560			kg	Water	
	Input	Resource	Water	401			kg	Ground	
	Input	Resource	Wind energy	0.343			MJ	Ground	
	Input	Resource	Wood	0.827			kg	Ground	
	Output	Emission	Cl-	0.428			kg	Water	
	Output	Emission	CO	0.107			kg	Air	
	Output	Emission	CO2	58.2			kg	Air	
Notes: Renewable.	Output	Emission	CO2	6.39			kg	Air	
	Output	Emission	COD	0.143			kg	Water	
Notes: Discharges to soil via sludge.	Output	Emission	Dyeing agents	0.0482			kg	Ground	
	Output	Emission	HCl	0.0012			kg	Air	
	Output	Emission	Methane	0.0823			kg	Air	
	Output	Emission	N total	0.0162			kg	Water	
	Output	Emission	N2O	0.00713			kg	Air	
	Output	Emission	NH3	0.0143			kg	Air	
	Output	Emission	NMVOC	0.14			kg	Air	
	Output	Emission	NMVOC, diesel engine	0.019			kg	Air	
	Output	Emission	NMVOC, oil combustion	0.00742			kg	Air	
	Output	Emission	NOx	0.329			kg	Air	
	Output	Emission	Oil	0.014			kg	Water	
	Output	Emission	Other organics	0.0116			kg	Water	
	Output	Emission	P Total	0.001			kg	Water	

	Output	Emission	Particles	0.0288			kg	Air	
	Output	Emission	Pesticides	0.06			kg	Ground	
	Output	Emission	SO42-	0.017			kg	Water	
	Output	Emission	SOx	0.108			kg	Air	
	Output	Emission	Suspended solids	0.00501			kg	Water	
	Output	Residue	Bulky	0.665			kg	Technosphere	
	Output	Residue	Cardboard	0.209			kg	Technosphere	
Notes: Non-elementary water discharges (substances not covered in data for wastewater treatment plant)	Output	Residue	Cl-	0.0117			kg	Technosphere	
Notes: Cotton fibres	Output	Residue	Cotton	0.159			kg	Technosphere	
	Output	Residue	Demolition	0.00308			kg	Technosphere	
	Output	Residue	Edge strips	0.163			kg	Technosphere	
	Output	Residue	Fabrics	0.306			kg	Technosphere	
Notes: Hazardous output	Output	Residue	Hazardous waste	0.0113			kg	Technosphere	
	Output	Residue	Heat	-81.3			MJ	Technosphere	
	Output	Residue	Highly radioactive	0.00206			kg	Technosphere	
	Output	Residue	Lubricant oil	0.00000568			m3	Technosphere	
	Output	Residue	Mineral waste	0.00684			kg	Technosphere	
Notes: Industrial waste	Output	Residue	Mixed industrial waste	0.00191			kg	Technosphere	
Notes: Industrial output	Output	Residue	Mixed industrial waste	1.56			kg	Technosphere	
	Output	Residue	Non-toxic chemicals	0.00377			kg	Technosphere	
	Output	Residue	Other	4.87			kg	Technosphere	
	Output	Residue	Paper	0.023			kg	Technosphere	
	Output	Residue	Polyethylene	0.013			kg	Technosphere	
	Output	Residue	Polypropylene	0.418			kg	Technosphere	
Notes: Ashes	Output	Residue	Slag/Ashes	0.00243			kg	Technosphere	
Notes: form energy production	Output	Residue	Slags and ash	0.0179			kg	Technosphere	
Notes: Elementary waste via non-elementary outputs.	Output	Residue	Sludge	0.68			kg	Technosphere	
Notes: Other.	Output	Residue	Spillage	0.0155			kg	Technosphere	
Notes: With packaging.	Output	Residue	Textile sample	0.314			kg	Technosphere	
Notes: Non-elementary water discharges (substances not covered in data for wastewater treatment plant)	Output	Residue	Total organic carbon	0.0719			kg	Technosphere	
	Output	Residue	Waste	0.975			kg	Technosphere	
	Output	Residue	Wood	0.747			kg	Technosphere	

About Inventory

Publication	Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector - a case study concerning fabrics for a sofa. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2004-7.pdf
Intended User	LCA and textile practitioners
General Purpose	Part of doctoral studies. ''The overall purpose of the studies is to give suggestions for solving some of the methodological issues within the LCA method when used in the field of textiles.''
Detailed Purpose	''The goal of this case study was to identify, map and discuss LCA methodological issues in the textile sector. This was done by carrying out an LCA study with the goal of ranking three fabric types for a sofa. i) The main reason for carrying out the study was that the LCA methodology is not fully developed and different sectors have different method development needs. This work was being done on the basis of interest from the textile industry in Sweden. ii) The study could be used for further development regarding methodological issues in the efforts to establish Product Specific Rules (PSRs) for Certified Environmental Declarations (EPDs) in the textile sector (the Swedish Environmental Management Council 2000) and for the modification

	work of the ISO 14040 (1997) - ISO 14043 (2000) standards. iii) It is intended to be used by purchasers, designers, etc., in the textile industry as well as for researchers and others working with the ISO 14040 (1997) - ISO 14043 (2000) standards.''
Commissioner	Stiftelsen Svensk Textilforskning - .
Practitioner	Lisbeth Dahllöf - .
Reviewer	Maria Walenius Henriksson - IFP Research AB
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	''Cotton cultivation - Inputs of fertilizers and pesticides were found on the home page of USDA (1999). Data were for Upland cotton, the main type according to the 2000 Crop Production Summary (2001). N, P2O5 and K2O were reported and they were translated to ammonium nitrate, diammonium phosphate and potassium nitrate since LCA data for these chemicals were known for Europe (methodological issue 15, Davis and Haglund 1999). The fertilizers reported are used in Texas (EPA 1999a) but potassium nitrate is the least common, only 0.7% of the potassium is from potassium nitrate.'' - Inputs of pesticides were found from the USDA (1999). Desiccants and defoliation agents are probably included in ''other chemicals'' as well as chemicals for disease control. The herbicide Trifluralin was applied to 74% of the area and the insecticide Malathion was applied to 56% of the area.'' ''Cotton bailing - The weight of packaging material and chlorinated phenol were not known but these are used in practice (Ellebäk Laursen et al1997).'' ''Weaving with sizing in Sweden - Liquefied petroleum gas (LPG), light fuel oil, starch: data comes from one cotton-weaving mill. The values of these flows were divided 50:50 between weaving and spinning. Although the representative from the weaving mill actually mentioned propane, here it is approximated to LPG. Not all weaving mills use LPG, it could therefore sometimes be left out. Here it is included, but the amount is not crucial to this study. - Data for lubricant oil is also a mean value from the three weaving mills. Grease usage is a mean value from two weaving mills. The amount/m was divided by the mean value for cotton weight derived from two cotton-weaving mills and a cotton wet treatment mill, 525 g/m (150 cm wide). - The fact that a mean value for the three fiber types was used in the calculation gave the effect of slightly different values for the flows of each fiber, since 10m fabrics is used for a sofa but the fabric is reported by weight (Data of weight of fabric used: cotton: 463-525 g/m, Trevira CS 373 g/m, Wool/PA 560 g/m, average value 465 g/m (150 cm wide)). This was corrected by setting factors for the different fibers on each side of the weaving activity, e g for Trevira CS: 465/373 before the weaving and 373/465 after the weaving. This resulted in inventory data per meter fabrics (and not per kg).'' ''Travel at work from cotton weaving mills site This activity deals with personnel travel in order to sell and inform about the fabric. Travel information given on an annual basis was translated into travel per m fabric made (including samples). The value 0.35 vkm/m fabric (vkm=vehicle km) was calculated from information from three weaving mill to be 0.67 vkm/kg cotton. Two of them also reported travel by air (0.07 vkm/m fabric) and one also reported train transport. Here only car transport was used. In the concept ''vkm'' it is assumed that about 1.6 people travel in each car (INFRAS 2000).'' ''Wet treatment and dyeing of cotton fabric Following steps were included: Singeing, desizing, washing, bleaching with H2O2, washing, mercerization, washing, dyeing, washing, finishing. The dyeing machine is a cold foulard and the dyeing agents are reactive. - Data are an average from 2 wet treatment mills and dyers of cotton, if not specifically noted under the table. One of the two had specific data for energy and chemical consumption for each step, but the other had only chemical consumption for each step and not specific energy use for the fabric. The lower energy value is from the plant, which knew the energy use for each process step. The plant, which only had data for total energy use, mainly has processes similar to this, although the specific red fabric had a more complicated wet treatment cycle than the average fabric types. Therefore the calculated average energy value is probably an underestimation for this red fabric. - Values for emissions were only available as plant totals. Therefore these data are a combination: chemicals use was for a specific fabric from one wet treatment mill. Water and energy use was for a specific fabric, for one wet treatment mill, and for the other it was derived from the total water and energy respectively, used in the factory (allocation on mass fabric; the economic value for the fabrics are similar (methodological issue 14)). One factory uses tap water, the other water from a river. Data were an average for the year 2000. - Packaging material for delivery back to weaving mill plant was collected from a third wet treatment mill (treats polyester and wool fabrics). - The production manager for one plant reported that Cu discharges to water were mainly from the equipment, and therefore it was not reported here. Dyeing agents fixate to about 75%, most of the rest is trapped in the sludge in either the plant or in the municipal wastewater-treatment plant. These 25% are added manually in appendix 1. All reported contents in sludge are derived from total amounts for the factory.'' ''Textile distribution at weaving mills site in Sweden Data about samples come from 2 weaving mills. Data about packaging material come from one weaving mill. Often the cardboard rolls are reused for the same application, but here it is assumed that the cardboards is reused elsewhere. The packaging used and total fabrics produced were known (both Trevira CS and Wool/PA).''

	""Upholstering of a sofa with cotton fabric Data regarding amount of fabric and spillage came from two upholstery companies." "Incineration of cotton fabric Emissions are general data for textiles incinerated in Sweden (Sundqvist 1999)." —— ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Importer of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The original publication includes more information about data. "The studies are being carried out at the Environmental Systems Analysis Department at Chalmers University of Technology in Gothenburg, Sweden and are being financed mainly by Stiftelsen Svensk Textilforskning and CPM, Centre for Environmental Assessment of Product and Material Systems."

SPINE LCI dataset: Crushing and cleaning of broken glass

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System	
Name	Crushing and cleaning of broken glass
Functional Unit	1 kg
Functional Unit Explanation	1 kg crushed and cleaned glass.
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Crushing and cleaning of broken glass.

System Boundaries	
Nature Boundary	No such parameters are measured in this study. No emissions from the production of electricity is included.
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are electricity consumption. Broken glass come from, and crushed and cleaned glass go, to the technosphere. No transports are included.
Allocations	

Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991-01-01
Data Type	Unspecified
Represents	See 'Function'.
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	In the life cycle of the cotton fabric, 10.1 kg cottonseed is also generated, but is not an output here because its benefit is calculated (system expansion). This data set is generated with the software LCAit. All values that are below 0.001 kg and values given in the unit Bq are excluded. These values can be found in the litterature reference.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Broken glass.	Input	Refined resource	Broken glass	1			kg	Technosphere	
Method: The amount 3 kWh/kg is recalculated to 0,011 MJ/kg in the reference literature.	Input	Refined resource	Electricity	0.011			MJ	Technosphere	
Notes: Crushed, cleaned glass.	Output	Product	Crushed, cleaned glass	1			kg	Technosphere	

About Inventory

Publication	Bauman H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and use of glass.
Detailed Purpose	To show the energy consumption for crushing and cleaning of broken glass.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	
About Data	
Notes	

SPINE LCI dataset: Cultivation and felling of trees for papermaking. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Cultivation and felling of trees for papermaking. ESA-DBP
Functional Unit	1 m3sub
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The unit used by forestry industry is for birchwood, m3sub, is a cubic meter of solid under bark wood substance. The weight of one m3sub of birch is in between 430-480kg. (...) For the calculations an average of 455 kg has been used.''
Process Type	Cradle to gate
Site	Unknown
Sector	Wood and wooden products excl. Furniture
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''Hardwood is a merchandise name for trees with flat fibres. The most important source, for Swedish forestry, of hardwood is eucalyptus grown in South America. Hardwood contributes with over 50%, but no data are available for this source, why Swedish birch has been assumed to be the source. Birch is a by-product in the Swedish forestry. It is the first plant that grows after harversting a forest and later cut down to give room for the trees the forester intend to grow on the land. (...) The data includes the cultivation, felling and transportation of logs to a road.'' This process is included in the system described in: Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Manufacturing of CD-R (Compact Disc-Recordable). ESA-DBP - Manufacturing of CD-ROM (Compact Disc - Read Only Memory). ESA-DBP - Dioctyl phthalate (DOP) production. ESA-DBP - Cardboard production (MDF based). ESA-DBP - Production of copypaper. ESA-DBP - Production of orthoxylene. ESA-DBP

System Boundaries	
Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) emissions to air and water.
Time Boundary	1996
Geographical Boundary	Sweden
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1996
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown

Literature Reference	Swedish Pulp and Paper Research Institute (STFI) database (1996), Sweden
Notes	In the life cycle of the cotton fabric, 10.1 kg cottonseed is also generated, but is not an output here because its benefit is calculated (system expansion). This data set is generated with the software LCAit. All values that are below 0.001 kg and values given in the unit Bq are excluded. These values can be found in the litterature reference.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Birch	4.55E+02			kg	Ground	Sweden
	Input	Refined resource	Diesel	1.08E+02			MJ	Technosphere	Sweden
	Output	Emission	CO	3.20E+01			g	Air	Sweden
	Output	Emission	CO2	8.49E+02			g	Air	Sweden
	Output	Emission	COD	1.30E-01			g	Water	Sweden
	Output	Emission	HC	2.20E+01			g	Air	Sweden
	Output	Emission	NOx	1.41E+02			g	Air	Sweden
	Output	Emission	N-tot	2.00E-02			g	Water	Sweden
	Output	Emission	Particulates	1.10E+01			g	Air	Sweden
	Output	Emission	SO2	1.70E+01			g	Air	Sweden
	Output	Product	Birchwood	1.00E+00			m3sub	Technosphere	Sweden

About Inventory

Publication	Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	The study was done for the purpose of master thesis.
Detailed Purpose	Excerpt from the report: ''The goal of this study is to undertake an life cycle assessment (LCA) of different alternatives for Ericsson to provide their customers with reference libraries to the Ericsson Consolo MD110 telephone exchange system. The different documentation alternatives investigated in this study are: plastic ring binders, paperbacks, CD-R records and CD-ROM records.''
Commissioner	Unknown - .
Practitioner	Torsten Beckman - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The inventory results for the whole life cycle (from cradle to grave) of binders, paperbacks, CD-Rs and CD-ROMs can be found in the reference report.

SPINE LCI dataset: CuNi10Fe extrusion and drawing of tubes

Administrative

Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-

Availability	Full availability

Technical System

Name	CuNi10Fe extrusion and drawing of tubes
Functional Unit	1 kg CuNi10Fe tubes
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast semi continually into bars. The bars are heated to 1000C and extruded over a core and then drawn cold. After an anneal the tubes are drawn to the final dimension of diameter 15 mm and 1 mm thickness. Coppercontaining sludge is a byproduct. 1.17 kg per kg product is recycled (0.3 in the melting and casting process and 0.87 kg in the forming process).

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German average industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting, casting and forming CuNi10Fe by drawing to tubes is 32.2 MJ/kg product. Of this energy 16.2 is associated with the melting and casting and 16.0 with the forming processes. This takes also the recyclate into consideration. An additional 0.4 MJ/kg has to be added for transport of additives and 0.1MJ/kg for transports within the company. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Output	By-product	Coppercontaining sludge	0.01			kg	Technosphere	
	Output	By-product	CuNi10Fe	1.17			kg	Technosphere	
	Output	Emission	CO	1.18			g	Air	
	Output	Emission	CO2	1.94			kg	Air	
	Output	Emission	HC	0.21			g	Air	
	Output	Emission	NO2	4.6			g	Air	
	Output	Emission	Particles	0.302			g	Air	
	Output	Emission	SO2	2.6			g	Air	
	Output	Residue	Ashes	0.08			kg	Ground	

	Output	Residue	Gypsum	0.03			kg	Ground	
	Output	Residue	Waste water	2			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuNi10Fe alloy consists of 89 w% Cu, 10 w% Ni and 1 w% Fe. This means that 0.89 of the primary energy for the above primary or secondary copper process has to be added (primary:37.2MJ, secondary:18.3MJ). The energy for production of nickel is 165 MJ/kg and steel 28 MJ/kg. In total this means adding 16.5 MJ for the nickel and 0.3 MJ for the iron. In total the primary energy to be added to cover the cradle to gate process is 54 MJ/kg CuNi10Fe for primary production and 35.1 MJ/kg CuNi10Fe for secondary production (alloying elements still primary production only copper secondary) The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: CuNi10Fe extrusion and pilgering of tubes

Administrative

Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System

Name	CuNi10Fe extrusion and pilgering of tubes
Functional Unit	1 kg CuNi10Fe tubes

Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast semi continually into bars. The bars are heated to 1000C and extruded over a core and then pilgered cold. After an anneal the tubes are drawn to the final dimension of diameter 15 mm and 1 mm thickness. Coppercontaining sludge is a byproduct. 0.63 kg per kg product is recycled (0.3 kg in the melting process, 0.33 in the forming process).

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German average industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting, casting and forming CuNi10Fe by pilgering to tubes is 24.1 MJ/kg product. Of this energy 12.1 is associated with the melting and casting and 12.0 with the forming processes. This takes also the recyclate into consideration. An additional 0.4 MJ/kg has to be added for transport of additives and 0.1MJ/kg for transports within the company. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	By-product	Coppercontaining sludge	0.01			kg	Technosphere	
	Output	By-product	CuNi10Fe	0.63			kg	Technosphere	
	Output	Emission	CO	0.97			g	Air	
	Output	Emission	CO2	1.47			kg	Air	
	Output	Emission	HC	0.19			g	Air	
	Output	Emission	NO2	3.72			g	Air	
	Output	Emission	Particles	0.238			g	Air	
	Output	Emission	SO2	1.95			g	Air	
	Output	Residue	Ashes	0.06			kg	Ground	
	Output	Residue	Gypsum	0.022			kg	Ground	
	Output	Residue	Waste water	2			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.

	-- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuNi10Fe alloy consists of 89 w% Cu, 10 w% Ni and 1 w% Fe. This means that 0.89 of the primary energy for the above primary or secondary copper process has to be added (primary:37.2MJ, secondary:18.3MJ). The energy for production of nickel is 165 MJ/kg and steel 28 MJ/kg. In total this means adding 16.5 MJ for the nickel and 0.3 MJ for the iron. In total the primary energy to be added to cover the cradle to gate process is 54 MJ/kg CuNi10Fe for primary production and 35.1 MJ/kg CuNi10Fe for secondary production (alloying elements still primary production only copper secondary) The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: CuNi10Fe semicontinuous casting

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	CuNi10Fe semicontinuous casting
Functional Unit	1 kg of cast CuNi10Fe
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany

Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast continually into bars. Slags and dust are byproducts.

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for continually cast copper is 9.61 MJ/kg bar. Additional 0.9 MJ/kg product for transports of help materials and help equipment should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Output	By-product	Copper slag and dust	0.015			kg	Technosphere	
	Output	Emission	CO	0.78			g	Air	
	Output	Emission	CO2	0.63			kg	Air	
	Output	Emission	HC	0.17			g	Air	
	Output	Emission	NO2	1.61			g	Air	
	Output	Emission	Particles	0.14			g	Air	
	Output	Emission	SO2	0.81			g	Air	
	Output	Residue	Ashes	0.025			kg	Ground	
	Output	Residue	Gypsum	0.09			kg	Ground	
	Output	Residue	Waste water	0.5			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .

Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuNi10Fe alloy consists of 89 w% Cu, 10 w% Ni and 1 w% Fe. This means that 0.89 of the primary energy for the above primary or secondary copper process has to be added (primary:37.2MJ, secondary:18.3MJ). The energy for production of nickel is 165 MJ/kg and steel 28 MJ/kg. In total this means adding 16.5 MJ for the nickel and 0.3 MJ for the iron. In total the primary energy to be added to cover the cradle to gate process is 54 MJ/kg CuNi10Fe for primary production and 35.1 MJ/kg CuNi10Fe for secondary production (alloying elements still primary production only copper secondary). The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: CuSn6 casting and drawing to wire

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	CuSn6 casting and drawing to wire
Functional Unit	1 kg CuSn6 wire
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast semicontinually into 20 mm bars. After a homogenizing heat treatment the wire is drawn to 7.8 mm. After annealing pickeling might be necessary. Then drawing and annealing is performed several times after each other until a thickness of 1.5 mm is achieved. Coppercontaining sludge is a byproduct. 0.12 kg per kg product is recycled (0.04 in the melting and casting process and 0.08 kg in the forming process).

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given

Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting, casting and forming CuSn6 by drawing to wire is 11.2 MJ/kg product. Of this energy 5.2 is associated with the melting and casting and 6 with the forming processes. This takes also the recyclate into consideration. An additional 0.4 MJ/kg has to be added for transport of additives and 0.1MJ/kg for transports within the company. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Output	By-product	Coppercontaining sludge	0.01			kg	Technosphere	
	Output	By-product	CuSn6	0.12			kg	Technosphere	
	Output	Emission	CO	0.4			g	Air	
	Output	Emission	CO2	0.71			kg	Air	
	Output	Emission	HC	0.17			g	Air	
	Output	Emission	NO2	1.9			g	Air	
	Output	Emission	Particles	0.145			g	Air	
	Output	Emission	SO2	0.93			g	Air	
	Output	Residue	Ashes	0.03			kg	Ground	
	Output	Residue	Gypsum	0.01			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory	
Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper

	products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuSn6 alloy consists of 94 w% Cu and 6w% Sn. This means that 0.94 of the primary energy for the above primary or secondary copper process has to be added (primary:39.3 MJ, secondary:19.3 MJ). The energy for production of tin is 70 MJ/kg. In total this means adding 4.2 MJ for the tin. In total the primary energy to be added to cover the cradle to gate process is 43.5 MJ/kg CuSn6 for primary production and 23.5 MJ/kg CuSn6 for secondary production (alloying element still primary production only copper secondary). The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: CuSn6 casting and rolling to strips

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	CuSn6 casting and rolling to strips
Functional Unit	1 kg CuSn6 strips
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast semicontinually into 17 mm thick plates. After a homogenizing heat treatment both sides are ground down. The strips are then cold rolled in 4 passes, annealed at 550C, pickled and then in up to 8 passes rolled to 0.5 mm. Some of the strips are then annealed again and rolled to 0.4 m in one pass. Coppercontaining sludge is a byproduct. 0.48 kg per kg product is recycled (0.06 in the melting and casting process and 0.42 kg in the forming process).

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995

Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting, casting and forming CuSn6 by rolling to sheets is 15.0-17.8 MJ/kg product. Of this energy 6.8 is associated with the melting and casting and 8.2-11.0 with the forming processes. The lower forming value is for a strip thickness of 0.5 mm and the higher with 0.35-0.4 mm.The energy values also take the recyclate into consideration. An additional 0.4 MJ/kg has to be added for transport of additives and 0.1MJ/kg for transports within the company. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	By-product	Coppercontaining sludge	0.01			kg	Technosphere	
	Output	By-product	CuSn6	0.48			kg	Technosphere	
	Output	Emission	CO	0.87			g	Air	
	Output	Emission	CO2	0.98			kg	Air	
	Output	Emission	HC	0.2			g	Air	
	Output	Emission	NO2	2.65			g	Air	
	Output	Emission	Particles	0.187			g	Air	
	Output	Emission	SO2	1.33			g	Air	
	Output	Residue	Ashes	0.04			kg	Ground	
	Output	Residue	Gypsum	0.015			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. --- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuSn6 alloy consists of 94 w% Cu and 6w% Sn. This means that 0.94 of the primary energy for the above primary or secondary copper process has to be added (primary:39.3 MJ, secondary:19.3 MJ). The energy for production of tin is 70 MJ/kg. In total this means adding 4.2 MJ for the tin. In total the primary energy to be added to cover the cradle to gate process is 43.5 MJ/kg CuSn6 for primary production and 23.5 MJ/kg CuSn6

		for secondary production (alloying element still primary production only copper secondary). The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: CuSn6 continuous casting

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	CuSn6 continuous casting
Functional Unit	1 kg cast CuSn6
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast continually into slabs or bars. Slags and dust are byproducts.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for continually cast copper is 4.85 MJ/kg slab or bar. Additional 0.9 MJ/kg product for transports of help materials and help equipment should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Output	By-product	Copper slag and dust	0.015			kg	Technosphere	
	Output	Emission	CO	0.67			g	Air	
	Output	Emission	CO2	0.35			kg	Air	

	Output	Emission	HC	0.35			g	Air	
	Output	Emission	NO2	1.08			g	Air	
	Output	Emission	Particles	0.11			g	Air	
	Output	Emission	SO2	0.43			g	Air	
	Output	Residue	Ashes	0.013			kg	Ground	
	Output	Residue	Gypsum	0.005			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuSn6 alloy consists of 94 w% Cu and 6w% Sn. This means that 0.94 of the primary energy for the above primary or secondary copper process has to be added (primary:39.3 MJ, secondary:19.3 MJ). The energy for production of tin is 70 MJ/kg. In total this means adding 4.2 MJ for the tin. In total the primary energy to be added to cover the cradle to gate process is 43.5 MJ/kg CuSn6 for primary production and 23.5 MJ/kg CuSn6 for secondary production (alloying element still primary production only copper secondary). The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: Cutting of steel bars (117x147 mm)

Administrative

Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System

Name	Cutting of steel bars (117x147 mm)
Functional Unit	One cut steel bar, 12.4 kg
Functional Unit Explanation	For the manufacturing of one bearing roller, one cut steel bar is needed. The cut steel bar has the dimensions 117 x 147 mm and weighs 12,4 kg. One SKF spherical roller bearing 232/530 consists of following components: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 bearing rollers (coated or non-coated)
Process Type	Unit operation
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	This activity is a sub-process step to the system ''Production of bearing rollers (à 9,2 kg)'' which can be found in the SPINE@CPM database. In this activity, steel bars with diameter 117 mm is cut into pieces (117 x 147 mm). These pieces are raw material for the production of bearing rollers at SKF in Göteborg. The steel bars are produced at the Stockbridge Works in Sheffield by Corus Engineering Steels, and are transported from Sheffield in England to Kode in Sweden for this cutting process (described in this activity) and then finally to SKF in Göteborg for further processing into bearing rollers. In this dataset the energy consumption for the cutting process in Kode, Sweden, is reported. Also internal transport by dieseltruck (15 seconds for each cut piece) and consumption of cutting fluid is reported.

System Boundaries

Nature Boundary	Emissions to air and water are not measured and could therefore not be reported in this dataset. The steel bars used for the rollers come from Corus Engineering Steel in Sheffield. The steel bars are 100 % made from scrap and is not seen as a resource, but comes from the technosphere. The steel scrap from the cutting process is assumed to be sent for deposition, since no data about recycling has been obtained. It ends therefore as waste in the technosphere. The cutting fluid has not been traced from the cradle or to the grave, because of lack of data.
Time Boundary	The data was collected during the autumn 2002.
Geographical Boundary	The cutting process takes place in Kode, in Sweden.
Other Boundaries	Internal transport within the cutting site in Kode is included in the study (=15 seconds). Assumptions were made at BeTe Trucks AB in Sweden how much energy a dieseltruck consume per hour (= 6 litres/h (average value)). The heating value for diesel (= 35, 31 MJ/litre) was found at Internet: www.fast-tech.com and the diesel consumption could be calculated to 0,88275 MJ/15 s. The diesel production is NOT included in the dataset. The electricity production is NOT included in this study.
Allocations	Allocations have been made according to weight and production.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	German copper industry
Method	Not given

Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for continually cast copper is 4.85 MJ/kg slab or bar. Additional 0.9 MJ/kg product for transports of help materials and help equipment should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 02-08-01 - 02-12-31 Data type: Calculated Method: The diesel consumption were given by the cutting company in seconds (15s). The consumption were recalculated into MJ. Assumptions were made at BeTe Trucks AB in Sweden how much energy a dieseltruck consume per hour (=6 litres/h (average value)). The heating value for diesel (=35, 31 MJ/litre) was found at Internet: www.fast-tech.com and the diesel consumption could be calculated to 0,88275 MJ/15 s.	Input	Refined resource	Diesel	0.88275			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity	0.92			kWh	Technosphere	Sweden
	Input	Refined resource	Steel bar	12.6			kg	Technosphere	Europe
	Output	Product	Cut steel bar	12.4			kg	Technosphere	Sweden
	Output	Residue	Steel scrap	0.2			kg	Technosphere	Sweden

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valild for cutting of steel bars of the same material and dimensions and with the same processing equipment.
About Data	Data from the cutting process in Kode is obtained from the product manager in Kode and from Niclas Thim.
Notes	

SPINE LCI dataset: CuZn37 casting and drawing to wire

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	CuZn37 casting and drawing to wire
Functional Unit	1 kg CuZn37 wire
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast semi continually into bars. The round bars are heated to 700-750C and pre-pressed to 10 mm wire indirectly through Merloch matrixes. The wire is then pickled and pre-drawn. After an anneal at 520C it is pickled again, treated and drawn to the final thickness of 3mm. After a final anneal the material is delivered. Coppercontaining sludge is a byproduct. 0.43 kg per kg product is recycled (0.14 in the melting and casting process and 0.29 kg in the forming process).

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting, casting and forming CuZn37 by drawing to wire is 11.4-15.7 MJ/kg product, depending on diameter. Of this energy 4.6 is associated with the melting and casting and 6.8-11.1 with the forming processes. This takes also the recyclate into consideration. An additional 0.4 MJ/kg has to be added for transport of additives and 0.1MJ/kg for transports within the company. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Output	By-product	CuZn37	0.43			kg	Technosphere	
	Output	By-product	CuZn-containing sludge	0.01			kg	Technosphere	

	Output	Emission	CO	0.81			g	Air	
	Output	Emission	CO2	0.85			kg	Air	
	Output	Emission	HC	0.18			g	Air	
	Output	Emission	NO2	2.82			g	Air	
	Output	Emission	Particles	0.15			g	Air	
	Output	Emission	SO2	0.92			g	Air	
	Output	Residue	Ashes	0.04			kg	Ground	
	Output	Residue	Gypsum	0.013			kg	Ground	
	Output	Residue	Waste water	2			kg	Water	

About Inventory	
Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuZn37 alloy consists of 63 w% Cu and 37w% Zn. This means that 0.63 of the primary energy for the above primary or secondary copper process has to be added (primary:26.3 MJ, secondary:12.9 MJ). The energy for production of zink 70 MJ/kg. In total this means adding 25.9 MJ for the zink. In total the primary energy to be added to cover the cradle to gate process is 52.2 MJ/kg CuZn37 for primary production and 38.8 MJ/kg CuZn37 for secondary production (alloying element still primary production only copper secondary). The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: CuZn37 casting and extruding over core to tubes

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System

Name	CuZn37 casting and extruding over core to tubes
Functional Unit	1 kg CuZn37 tubes
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast semi continually into bars. The bars are heated to 700C and extruded over a core. After pickling and heat treating the tubes are predrawn, annealed at 520C, pickled and treated again and finally drawn to the dimension of diameter 22 mm and 1.5 mm thickness. Coppercontaining sludge is a byproduct. 0,77 kg per kg product is recycled (0.14 in the melting and casting process and 0.63 kg in the forming process).

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting, casting and forming CuZn37 by drawing to tubes is 18.3 MJ/kg product. Of this energy 5.6 is associated with the melting and casting and 12.7 with the forming processes. This takes also the recyclate into consideration. An additional 0.4 MJ/kg has to be added for transport of additives and 0.1MJ/kg for transports within the company. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Output	By-product	CuZn37	0.77			kg	Technosphere	
	Output	By-product	CuZn-containing sludge	0.01			kg	Technosphere	
	Output	Emission	CO	0.99			g	Air	
	Output	Emission	CO2	1.12			kg	Air	
	Output	Emission	HC	0.19			g	Air	
	Output	Emission	NO2	2.69			g	Air	
	Output	Emission	Particles	0.21			g	Air	
	Output	Emission	SO2	1.49			g	Air	
	Output	Residue	Ashes	0.04			kg	Ground	
	Output	Residue	Gypsum	0.017			kg	Ground	
	Output	Residue	Waste water	2			kg	Water	

About Inventory	
Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuZn37 alloy consists of 63 w% Cu and 37w% Zn. This means that 0.63 of the primary energy for the above primary or secondary copper process has to be added (primary:26.3 MJ, secondary:12.9 MJ). The energy for production of zink 70 MJ/kg. In total this means adding 25.9 MJ for the zink. In total the primary energy to be added to cover the cradle to gate process is 52.2 MJ/kg CuZn37 for primary production and 38.8 MJ/kg CuZn37 for secondary production (alloying element still primary production only copper secondary). The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: CuZn37 casting and rolling to strips

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	CuZn37 casting and rolling to strips
Functional Unit	1 kg CuZn37 strips
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany

Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast semi continually into bars. The bars are heated to 850C and pre-rolled in up to 14 passes to a dimension of 11-14 mm. After cooling both sides are ground down. The strips are then cold rolled in 4 passes, annealed at 550C, pickled and then in up to 8 passes rolled to 0.5 mm. Some of the strips are then annealed again and rolled to 0.35 mm in one pass. Coppercontaining sludge is a byproduct. 0.54 kg per kg product is recycled (0.12 in the melting and casting process and 0.42 kg in the forming process).

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting, casting and forming CuZn37 by rolling to sheets is 13.1-15.9 MJ/kg product. Of this energy 4.9 is associated with the melting and casting and 8.2-11.0 with the forming processes. The lower forming value is for a strip thickness of 0.5 mm and the higher with 0.35 mm.The energy values also take the recyclate into consideration. An additional 0.4 MJ/kg has to be added for transport of additives and 0.1MJ/kg for transports within the company. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Output	By-product	CuZn37	0.54			kg	Technosphere	
	Output	By-product	CuZn-containing sludge	0.01			kg	Technosphere	
	Output	Emission	CO	0.87			g	Air	
	Output	Emission	CO2	0.9			kg	Air	
	Output	Emission	HC	0.22			g	Air	
	Output	Emission	NO2	2.44			g	Air	
	Output	Emission	Particles	0.178			g	Air	
	Output	Emission	SO2	1.18			g	Air	
	Output	Residue	Ashes	0.04			kg	Ground	
	Output	Residue	Gypsum	0.013			kg	Ground	
	Output	Residue	Waste water	4			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of

	Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuZn37 alloy consists of 63 w% Cu and 37w% Zn. This means that 0.63 of the primary energy for the above primary or secondary copper process has to be added (primary:26.3 MJ, secondary:12.9 MJ). The energy for production of zink 70 MJ/kg. In total this means adding 25.9 MJ for the zink. In total the primary energy to be added to cover the cradle to gate process is 52.2 MJ/kg CuZn37 for primary production and 38.8 MJ/kg CuZn37 for secondary production (alloying element still primary production only copper secondary). The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: CuZn37 continuous casting

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	CuZn37 continuous casting
Functional Unit	1 kg cast CuZn37
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast continually into slabs. Slags and dust are byproducts.

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for continually cast copper is 3.30 MJ/kg slab. Additional 0.9 MJ/kg product for transports of help materials and help equipment should be added. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Output	By-product	Copper slag and dust	0.03			kg	Technosphere	
	Output	Emission	CO	0.66			g	Air	
	Output	Emission	CO2	0.25			kg	Air	
	Output	Emission	HC	0.15			g	Air	
	Output	Emission	NO2	0.91			g	Air	
	Output	Emission	Particles	0.1			g	Air	
	Output	Emission	SO2	0.31			g	Air	
	Output	Residue	Ashes	0.025			kg	Ground	
	Output	Residue	Gypsum	0.003			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	

Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuZn37 alloy consists of 63 w% Cu and 37w% Zn. This means that 0.63 of the primary energy for the above primary or secondary copper process has to be added (primary:26.3 MJ, secondary:12.9 MJ). The energy for production of zink is 70 MJ/kg. In total this means adding 25.9 MJ for the zink. In total the primary energy to be added to cover the cradle to gate process is 52.2 MJ/kg CuZn37 for primary production and 38.8 MJ/kg CuZn37 for secondary production (alloying element still primary production only copper secondary). The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: CuZn37Pb chill casting

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	CuZn37Pb chill casting
Functional Unit	1 kg cast CuZn37Pb
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metals and block metal is transported, melted, cast and cleaned.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995

Data Type	Unspecified, expert outspoke
Represents	Average German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting, casting and cleaning of CuZn37Pb is 15.95 MJ/kg. For the melting induction and fossil fuel heated furnaces are used. For electricity a German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/kg for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. Only small amounts of water are used.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	By-product	Copper slag and fly ash	0.1			kg	Technosphere	
	Output	Emission	CO	0.59			g	Air	
	Output	Emission	CO2	0.95			kg	Air	
	Output	Emission	HC	0.24			g	Air	
	Output	Emission	NO2	2.28			g	Air	
	Output	Emission	Particles	0.24			g	Air	
	Output	Emission	SO2	1.24			g	Air	
	Output	Residue	Ashes	0.04			kg	Ground	
	Output	Residue	Gypsum	0.014			kg	Ground	
	Output	Residue	Sand	0.24			kg	Ground	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	For production of kokille CuZn37Pb pure metals and block metal are added in not given proportions. Energies and emissions for producing those have to be included when making a cradle to gate assessment.

SPINE LCI dataset: CuZn39Pb2 casting and pressing to rods

Administrative

Finished	Y

Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System

Name	CuZn39Pb2 casting and pressing to rods
Functional Unit	1 kg CuZn39Pb2 bars
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	Pure metal is transported, melted in an induction furnace, alloying elements are added and the alloy is cast semi continually into bars. After heating the round bars to 700C most often the bars are pressed indirectly througn Merloch matrixes to 19 mm hexagon bars. These bars are then pickled and drawn to the final size of 17mm. Anneals in between and at the end might be necessary. Coppercontaining sludge is a byproduct. 0.5 kg per kg product is recycled (0.14 in the melting and casting process and 0.36 kg in the forming process).

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting, casting and forming CuZn39Pb2 by drawing to bars is 9.4-11.6 MJ/kg product. Of this energy 4.8 is associated with the melting and casting and 4.6-6.8 with the forming processes. The higher forming value is for a smaller bar size.The energy values also take the recyclate into consideration. An additional 0.4 MJ/kg has to be added for transport of additives and 0.1MJ/kg for transports within the company. A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Output	By-product	CuZn39Pb2	0.5			kg	Technosphere	
	Output	By-product	CuZn-containing sludge	0.01			kg	Technosphere	
	Output	Emission	CO	0.84			g	Air	
	Output	Emission	CO2	0.61			kg	Air	
	Output	Emission	HC	0.17			g	Air	
	Output	Emission	NO2	2.05			g	Air	

	Output	Emission	Particles	0.153			g	Air	
	Output	Emission	SO2	0.86			g	Air	
	Output	Residue	Ashes	0.01			kg	Ground	
	Output	Residue	Gypsum	0.005			kg	Ground	
	Output	Residue	Waste water	2			kg	Water	

About Inventory	
Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. --- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated data for primary (data set ''High purity copper production from primary raw materials'') or secondary (data set ''High purity copper production from secondary raw materials'') production must be added to the present data. If using primary material data for ore mining and concentration (data set ''Copper ore mining and concentration'') also has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%. To this the energy for primary production of pure metal 21.8 MJ/kg copper must be added. For secondary production no energy for concentration and mining is used but 20.55 MJ/kg copper is to be added. For alloys additional energy has to be included for the manufacturing of the additives. A CuZn39Pb2 alloy consists of 59 w% Cu, 39 w% Zn and 2 w% Pb. This means that 0.59 of the primary energy for the above primary or secondary copper process has to be added (primary:24.6 MJ, secondary:12,1 MJ). The energy for production of zinc is 70 MJ/kg and lead 25 MJ/kg. In total this means adding 27.3 MJ for the zinc and 0.5 MJ for the lead. In total the primary energy to be added to cover the cradle to gate process is 52.4 MJ/kg CuZn39Pb2 for primary production and 39.9 MJ/kg CuZn39Pb2 for secondary production (alloying elements still primary production only copper secondary). The same procedure can be used to add emissions and other information for the production of alloys.

SPINE LCI dataset: Czech Republic, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Czech Republic, electricity generation mix 1998

Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Czech Republic
Sector	Energyware
Owner	Czech Republic
Technical system description	The generation of electricity with different power generating systems in the Czech Republic during the year 1998.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	German copper industry
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Represents: Wind	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	13178			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	1396			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	2053			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	40179			GWh	Technosphere	
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	491			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	598			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	6113			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	616			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	64624			GWh	Technosphere	

About Inventory	
Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Delivery van, distribution, diesel

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Delivery van, distribution, diesel
Functional Unit	1 tonkm, 50 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 %. An utilisation level of 50 % is considered to be representative for Swedish domestic distribution traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of delivery van for distribution, approximately 5.5 m long with a curb weight of 3.5 tons and a maximum loading capacity by weight of 1.4 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: 1.8 l/10km. Utilisation level: 50% by weight. The data represents vans constructed before 1996 and mixed driving (urban and highway) and includes cold starts and aging effects.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for vans constructed before 1996.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. Empty trips are not included. *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests .
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission data presented by Swedish Hauliers Assosiation in cooperation with ASG, BTL and ''Nordisk Transport''. The basis for the data originates from IVL (reference not stated by NTM). The utilisation level (loading factor) is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The emissions were calculated using emission factors, together with assumptions on the fuel consumption, type of fuel used and utilisation level. (g/vkm) Petrol Diesel NOx: 0.10 0.50 HC: 0.20 0.15 CO: 1.50 0.50 PM: 0.005 0.10 Fuel cons. 2.8 l/10km 1.8 l/10km The quantity value for the energy use refer to average fuel consumption. The emissions of CO2 and SO2 is based on the fuel consumption.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	2.5			kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.71			g	Air	Sweden
	Output	Emission	CO2	662			g	Air	Sweden
	Output	Emission	HC	0.21			g	Air	Sweden
	Output	Emission	NOx	0.71			g	Air	Sweden
	Output	Emission	Particles	0.14			g	Air	Sweden
	Output	Emission	SO2	0.00083			g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation)

	The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Björkman, Mikael - BTL 412 97 Göteborg .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used in terminal based transport systems in Sweden:*** *--Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel***

	The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The data for emissions is based on emission factors. The origin of the emission factors is not specified. This means that several parameters that influence the energy use and emissions in regular traffic are probably not considered, e.g. climate, topography, driving technique, maintenance etc. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. Data for vans differs from other trucks as emission data includes effects due to cold starts, aging effects and operations on different road tyes. (a mix of urban and highway traffic)
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Delivery van, distribution, petrol

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Delivery van, distribution, petrol
Functional Unit	1 tonkm, 50 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 %. An utilisation level of 50 % is considered to be representative for Swedish domestic distribution traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden

Technical system description	Operation of delivery van for distribution, approximately 5.5 m long with a curb weight of 3.5 tons and a maximum loading capacity by weight of 1.4 tons. Fuel: petrol (sulphurous content: 180 ppm). Fuel consumption: 2.8 l/10km. Utilisation level: 50% by weight. The data represents vans constructed before 1996 and mixed driving (urban and highway) and includes cold starts and aging effects.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for vans constructed before 1996.
Geographical Boundary	Data is based on Swedish conditions.
Other Boundaries	The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. Empty trips are not included. *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission data presented by Swedish Hauliers Assosiation in cooperation with ASG, BTL and ''Nordisk Transport''. The basis for the data originates from IVL (reference not stated by NTM). The utilisation level (loading factor) is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The emissions were calculated using emission factors, together with assumptions on the fuel consumption, type of fuel used and utilisation level. (g/vkm) Petrol Diesel NOx: 0.10 0.50 HC: 0.20 0.15 CO: 1.50 0.50 PM: 0.005 0.10 Fuel cons. 2.8 l/10km 1.8 l/10km The quantity value for the energy use refer to average fuel consumption. The emissions of CO2 and SO2 is based on the fuel consumption.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Gasoline	3.5			kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden

	Output	Emission	CO	2.1			g	Air	Sweden
	Output	Emission	CO2	929			g	Air	Sweden
	Output	Emission	HC	0.29			g	Air	Sweden
	Output	Emission	NOx	0.14			g	Air	Sweden
	Output	Emission	Particles	0.0071			g	Air	Sweden
	Output	Emission	SO2	0.12			g	Air	Sweden

About Inventory	
Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Björkman, Mikael - BTL 412 97 Göteborg .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a

trailer at the terminal for further transport.
--*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited
--*Parcel goods (<100 kg)* are normally handled in small vehicles

The following vehicles and equipages are used in terminal based transport systems in Sweden:
--*Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels.
--*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic.
--*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic.
--*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--*Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic.

Utilisation level
The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure.

International road transports
The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.

About Data

The data for emissions is based on emission factors. The origin of the emission factors is not specified. This means that several parameters that influence the energy use and emissions in regular traffic are probably not considered, e.g. climate, topography, driving technique, maintenance etc. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.

Data for vans differs from other trucks as emission data includes effects due to cold starts, aging effects and operations on different road tyes. (a mix of urban and highway traffic)

Notes

The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM.
The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation.

	The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Denmark, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Denmark, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Denmark
Sector	Energyware
Owner	Denmark
Technical system description	The generation of electricity with different power generating systems in Denmark during the year 1998. Denmark includes Greenland and the Danish Faroes.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	NTM
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	1456			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	23648			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	27			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	2780			GWh	Technosphere	
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	38			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	4968			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	8166			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	41083			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998

	European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: De-watering of water-sludge

Administrative	
Finished	Y
Date Completed	1999-04-19
Copyright	
Availability	public

Technical System	
Name	De-watering of water-sludge
Functional Unit	1 m3 of recieved water-sludge from Reci Industri Halmstad.
Functional Unit Explanation	Water-sludge is delivered to the facility by truck from Reci Halmstad. The water-sludge is a waste product from the biological treatment of of the oil-contaminated water at Reci Halmstad.
Process Type	Gate to gate
Site	Reci Industri AB Box 48047 418 21 Göteborg
Sector	Waste treatment
Owner	Reci Industri AB Box 48047 418 21 Göteborg

Technical system description	Water-sludge arrives from Reci Halmstad by truck to Reci's facility at Skarvik, Göteborg. In the de-watering facility waste is separated into a solid phase and a liquid phase. The solid phase, mostly containing of sediment from oil-separators and sand, are deposited at Torsviken. The water phase is led to the water treatment facility at Reci Industri Göteborg, Cicelan (Not part of the studied system). The waste treated at the de-watering facility contains sludge 11 000 tonnes / year, liquid industrial waste 12 000 tonnes / year and oil sludge 3000 tonnes / year. A decription about the water treatment facility is found in the SPINE report ''Treatment of oil-contaminated waste water''

System Boundaries

Nature Boundary	Other impacts then the landfill caused by the solid phase are not calculated. Resources that are not seen as limited in Sweden are neglected e.g. land usage and fresh water. · The electricity utilised by the system is only seen as a resource and the origin is not interpreted.
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary for the converting of waste-oil is set to Sweden.
Other Boundaries	The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected as well. · No resource use or impacts from Reci Göteborg is allocated to the de-watering of water-sludge. It is today impossible to say how much the de-watering facility contributes with as no measurements have been made. The treatment of water-sludge from Reci Halmstad is in its turn only a smaller part of the total amount de-watered at the facility (501 m3 of totally 26 000 m3). · The amount of pollutants in the water- and the solid-phase are not known. But if they where to be measured the contribution from water-sludge should be calculated with the data about the water-sludge contents in mind. The pollutants are supposed to be adsorbed in the solid-phase deposited at Torsviken. · As the energy consumption is not known and is supposed to be minor no energy use is loaded upon the de-watering of water-sludge. · No spill occurs in the plants. · The loading and unloading step is neglected in terms of consuming resources or emitting outputs.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	
Represents	NTM
Method	The general description of the plant is taken from the environmental report of 1997 for Reci Göteborg and interviews with the employees. Information about the de-watering facility is achieved through interviews with Christian Artén, process engineer and Lars Schaff, environmental manager at Reci Göteborg. Bengt Borg, production manager at Reci Halmstad has contributed with information about the water-sludge. The substances are divided with the total amount of treated water-sludge to represent the amount per functional unit.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1997 Literature: Environmental report of 1997 for Reci Industri Halmstad. Bengt Borg production manager Reci Industri Halmstad. Lars Schaff environmental	Input	Refined resource	Water-sludge	1			m3	Technosphere	Sweden

manager Reci Göteborg. Notes: According to analyses performed on the water-sludge at Reci Industri Halmstad the contents of the water-sludge varies with several 100 % from time to time. total amount recieved 501 m3.									
Date concieved: 1997 Data type: Calculated Method: Based on a geometrical average on the analyses of the water-sludge solid content. Literature: Water-sludge analyse from Reci Industri Halmstad. Christian Artén process manager reci Industri Göteborg. Notes: Deposited at Torsviken. No analyse of the contents has been performed.	Output	Residue	Waste	0.15			m3	Technosphere	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on a geometrical average on the analyses of the water-sludge's solid content. Literature: Water-sludge analyse from Reci Industri Halmstad. Notes: The water is led to Ciclean, the water tratment facility at Reci Göteborg. No treatment or analyse on the amount of emissions have been made.	Output	Residue	Waste water	0.85			m3	Ocean	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology -- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally the result is a part of Reci's ISO 14000 certification, which acts as a guarantee to the customers. The quality of the inquiry is set due to the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emissions from de-watering of water-sludge from Reci Halmstad.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are specific for de-watering of water-sludge from Reci Halmstad.
About Data	· The water-sludge often varies much in its contents. The calculation is performed based on an average value of the data presented for the water-sludge. The data is received from analysing the water-sludge at Reci Halmstad. The percentage of dry substance in the water sludge is based on an average value 15 per cent. This gives that 15 per cent of the water sludge will end up as a solid phase and the rest as water. Mass-balance · As the emissions or pollutants in the water is unknown the mass balance follows the simple assumption above, that 15 per cent becomes sediment and the rest water.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Diesel combustion

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System	
Name	Diesel combustion
Functional Unit	MJ
Functional Unit Explanation	Per MJ energy generated from combustion of diesel in a vehicles engine.
Process Type	Gate to gate
Site	Sweden
Sector	Fuel
Owner	Sweden
Technical system description	Diesel combustion is a gate-to-gate scenario using diesel fuel (treated separately in another activity) to generate energy to put a vehicle in motion.

System Boundaries	
Nature Boundary	Emissions to air from combustion of the fuel are included. Other impacts from the operation of the vehicle are not included.
Time Boundary	The data describes the situation prior to 1991.
Geographical Boundary	N/A
Other Boundaries	N/A
Allocations	N/A
Systems Expansions	The system does not include the production of the diesel fuel.

Flow Data	
General Activity QMetaData	
Date Conceived	1991-01-01
Data Type	Unspecified
Represents	NTM
Method	Emissions caused by combustion of diesel fuel in vheicle engins
Literature Reference	A-M Tillman et al. Packaging and the environment, SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Diesel	1			MJ	Technosphere	Sweden
	Output	Emission	CO	0.3			g	Air	Sweden
Date concieved: 1991-01-01 Data type: Unspecified Method: The carbon content of the fuel gives an emission of 74,6 g CO2/MJ.	Output	Emission	CO2	74.6			g	Air	Sweden
	Output	Emission	HC	0.2			g	Air	Sweden

	Output	Emission	NOx	1.3			g	Air	Sweden
	Output	Emission	Particulates	0.1			g	Air	Sweden
Date concieved: 1991-01-01 Data type: Unspecified Method: Assuming a sulphur content in the diesel fuel of 0,3% by weight, which when converted gives 0,14 g/MJ fuel consumed.	Output	Emission	SO2	0.14			g	Air	Sweden
	Output	Product	Diesel energy	1			MJ	Technosphere	Sweden

About Inventory	
Publication	A-M Tillman et al. Packaging and the environment, SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden. -- Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners.
General Purpose	To be a part of a complete scenario, incorporating DIESEL PRODUCTION (extraction, transport & refining) and this step DIESEL COMBUSTION.
Detailed Purpose	Includes the input of diesel fuel and the emissions to air caused by its combustion.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	
About Data	The emissions were calculated from the carbon, sulphur etc. contents of the diesel fuel. Further details are found under general- and specific QMetaData.
Notes	N/A

SPINE LCI dataset: Diesel driven freight train, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Diesel driven freight train, future
Functional Unit	1 tonkm, 55 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 55 %. An utilisation level of 55 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport

Owner	Sweden
Technical system description	Operation i.e. propulsion of a freight train with a diesel-driven engine. The locomotive engine represents best available technology, not yet in use. Engines originally developed for trucks are assumed to be installed in the locomotive engine. Maximum gross weight of the train: 1200 tonnes. Maximum available loading capacity with regard to weight 972 tonnes.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents best available technology in 1997.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 55 %. The utilsation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the engine -Use of lubricating oil -Wear of brake lining, rail and wheel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the engine -Erection and maintenance of infrastructure -After-treatment of the engine -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by a new test cycle, together with assumptions on the fuel consumption, type of fuel used (diesel environmental class 1) and utilisation level (55%). See specific QMetaData for each flow.
Literature Reference	A-M Tillman et al. Packaging and the environment, SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. ***The following data was used in the calculations:*** *Assumptions given by the Swedish State Railways:* -Average fuel consumption: 3,5 l/km -Utilisation level: 55 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class*	Input	Refined resource	Diesel environmental class 1	0.21			MJ	Technosphere	

1(given by the Swedish Petroleum Institute): -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.0026			g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish State Railways:* -Average fuel consumption: 3,5 l/km -Utilisation level: 55 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1(given by the Swedish Petroleum Institute):* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -CO2 emission: 73 g/MJ fuel -Sulphur content: 10 ppm	Output	Emission	CO2	15.6			g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.0026			g	Air	
Date concieved: 1996-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a a new test cycle, on the engine. The emission factors were given in g/kWh where kWh refers to mechanical work done by the engine. The tests was perfomed by Motortestcenter. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emision factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish State Railways:* -Average fuel consumption: 3,5 l/km -Utilisation level: 55 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1(given by the Swedish Petroleum Institute):* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were:* -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data can be found in Ahlvik. Literature: Ahlvik P., Almén J., Grägg K., Laveskog A. *Avgasemissioner med alternativa bränslen* Motortestcenter, februari 1996 (Published in SOU 1996:184 *Bilagor till betänkande av alternativbränsleutredningen*)	Output	Emission	NOx	0.13			g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.00051			g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish State Railways:* -Average fuel consumption: 3,5 l/km -Utilisation level: 55 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1(given by the Swedish Petroleum Institute):* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm	Output	Emission	SO2	0.0001			g	Air	

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Ingela Melkersson, SJ Stab Information, contact person for rail transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Trouve, Johan - SJ (Swedish State Railways), Stab Information, Box 1522, 401 50 Göteborg.
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions for Swedish train traffic. The data represents best available technology not yet in use.
About Data	The data is based on tests on performed in a laboratory according to a new test cycle (proposed for standardisation). This means that several parameters that influence the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Since the exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. ***Utilisation level*** The average utilisation level for diesel-driven trains (55%) are higher than for electrically driven trains, inter alia because the trains generally runs shorter distances. The average utilisation level includes transportation of empty trucks and was based on statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively. The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives.

	The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Diesel driven freight train, T44 engine

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Diesel driven freight train, T44 engine
Functional Unit	1 tonkm, 55 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 55 %. An utilisation level of 55 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of freight train with a diesel-driven T44 engine. Diesel engines is mainly used for shunting and for regular traffic in sections where there is no aerial line. Maximum gross weight of the train: 1200 tonnes. Maximum available loading capacity with regard to weight 972 tonnes.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents engines in use 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 55 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the engine -Use of lubricating oil -Wear of brake lining, rail and wheel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the engine -Erection and maintenance of infrastructure -After-treatment of the engine -Handling of production rests

Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996-01-01-1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the fuel consumption, type of fuel used (diesel environmental class 3) and utilisation level (55%). See specific QMetaData for each flow.
Literature Reference	A-M Tillman et al. Packaging and the environment, SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 3. ***The following data was used in the calculations:*** *Assumptions given by the Swedish State Railways:* -Average fuel consumption: 3,5 l/km. -Utilisation level: 55 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 3 (given by the Swedish Petroleum Institute):* -Thermal value: 9,952 kWh/l -Density: 0,820-0,860 kg/l -Sulphur content: 500 ppm	Input	Refined resource	Diesel environmental class 3	0.23			MJ	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.0239			g	Air	Sweden
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish State Railways:* -Average fuel consumption: 3,5 l/km. -Utilisation level: 55 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 3 (given by the Swedish Petroleum Institute):* -Thermal value: 9,952 kWh/l -Density: 0,820-0,860 kg/l -Sulphur content: 500 ppm -CO2 emission: ???	Output	Emission	CO2	16.8			g	Air	Sweden
Method: See QMetaData for NOx	Output	Emission	HC	0.0148			g	Air	Sweden
Date concieved: 1996-01-01-1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors (g/kWh) obtained by a standardised test cycle, ECE R49 on the engine, where kWh refers to mechanical work done by the engine. The tests was performed by Motortestcenter. ***The following data was used in the calculations:*** *Assumptions given by the Swedish State Railways:* -Average fuel consumption: 3,5 l/km. -Utilisation	Output	Emission	NOx	0.37			g	Air	Sweden

level: 55 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 3 (given by the Swedish Petroleum Institute):* -Thermal value: 9,952 kWh/l -Density: 0,820-0,860 kg/l -Sulphur content: 500 ppm *The emission factors were :* -NOx 19,4 g/kWh -HC 0,77 g/kWh -CO 1,27 g/kWh -Particles 0,51 g/kWh The data is found in ''Exhaust emission from a two stroke lokomotive engine''. The ECE R49 is a steady state cycle for heavy duty truck engines. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Literature: Exhaust emissions from a two stroke locomotive engine, MTC rapport 96:4, Motortestcenter, Svensk Bilprovning, 1996									
	Output	Emission	Particles	0.0095			g	Air	Sweden
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish State Railways:* -Average fuel consumption: 3,5 l/km. -Utilisation level: 55 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 3 (given by the Swedish Petroleum Institute):* -Thermal value: 9,952 kWh/l -Density: 0,820-0,860 kg/l -Sulphur content: 500 ppm	Output	Emission	SO2	0.0027			g	Air	Sweden

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Ingela Melkersson, SJ Stab Information, contact person for rail transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and

	emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Trouve, Johan - SJ (Swedish State Railways), Stab Information, Box 1522, 401 50 Göteborg.
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information on how the goods are handled and the transport is carried out. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used: *Electrically driven freight trains* transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. *Electrically driven combi train* consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transportation by combi train is about 5 % of the total transportation by electrically driven goods trains. *Electrically driven system trains* are not recoupled on the way and always take the same route between two addresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is 50% or higher. System trains ordinarily runs special transportation assignments for different types of industry. *Diesel driven engines* (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the Swedish railway system that are not electrified. SJ also uses a smaller diesel driven engine (V5) for shunting. The V5 engine has a capacity of 450-500 tonnes gross weight and is not ordinarily used for regular traffic. ***Marshalling*** The major part of the goods is marshalled at 6 main junctions were the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (vallväxling) -Fly shunting (planväxling) ***Distance*** The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ (Swedish State Railways) has developed environmental data software with a database of distances between 70 different places, considering the infrastructure. The database does however not give information on which lines that are not electrified. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.
About Data	***Test cycle*** The data is based on tests on one locomotive engine performed in a laboratory according to a standardised test cycle (ECE R49). This means that several parameters that influence the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Since the exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle was developed to represent long-distance traffic. ***Utilisation level*** The data is based on an average utilisation level of 55% (including transportation of empty trucks). The average utilisation level was based on statistics from 1993 from the Swedish State Railways. Today, the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively, and it is not possible to discern a difference in utilisation between electrically driven and diesel driven freight trains.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at

	the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Diesel EN590, EU-15, cradle-to-gate, energy allocation - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Diesel EN590, EU-15, cradle-to-gate, energy allocation - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of diesel EN590, EU-15
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	There are two data sources for diesel production, which have been considered to be the best available data to be published in the f3 project; data from an LCA for diesel produced in Sweden (Öman 2011) and data from the ELCD database. For Swedish MK1 diesel the data from Öman 2011 have been chosen and for the diesel according to the EN590 standard, the ELCD data were applied. When looking at the GWP for instance, the data applied for MK1 is 27 % lower than the ELCD data applied for EN590. This data set describes a mass-weighted average refinery for Europe. The data set considers the whole supply chain from exploration over crude oil extraction to transport to refinery. The background system is addressed as follows: Electricity, Thermal energy: The electricity (and thermal energy as by-product) used is modelled according to the individual country-specific situation. The country-specific modelling is achieved on multiple levels. Firstly the individual power plants in service are modelled according to the current national grid. This includes net losses and imported electricity. Second, the national emission and efficiency standards of the power plants are modelled. Third, the country-specific fuel supply (share of resources used, by import and / or domestic supply) including the country-specific properties (e.g. element and energy contents) are accounted for. Fourth, the import, transport, mining and exploration processes for the energy carrier supply chain are modelled according to the specific situation of each power-producing country. The different mining and exploration techniques (emissions and efficiencies) in the different exploration countries are accounted for according to current engineering knowledge and information. Steam: The steam supply is modelled according to the individual country-specific situation with regard to the technology efficiencies and energy carriers used. Efficiencies range from 84% to 94% in relation to the representative energy carrier (gas, oil, coal). Coal, crude oil and natural gas used for the generation of steam are modelled according to the specific import situation.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Europe (EU15 average)

Other Boundaries	
Allocations	For the combined crude oil, natural gas and natural gas liquids production allocation by net calorific value is applied. For all products of the refinery, allocation by mass and net calorific value is applied. The manufacturing route of every refinery product is modelled and so the effort of the production of these products is calculated specifically. Two allocation rules are applied: The raw-material (crude oil) consumption of the respective stages, which is necessary for the production of a product or an intermediate product, is allocated by energy (mass of the product * calorific value of the product). In these way products with high caloric values, e.g. gasoline or gases are assigned to higher raw material consumption and so higher environmental impacts compared with low caloric value products (e.g. asphalt, residual oil). The energy consumption (thermal energy, steam, electricity) of a process, e.g. atmospheric distillation, being required by a product or a intermediate product, are charged on the product according to the share of the throughput of the stage (mass allocation). The products, which are more complex to produce and therefore pass a lot of refinery facilities e.g. gasoline, are assigned with a higher energy consumption (and so higher emissions) compared with e.g. straight run products.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	NTM
Method	The data set covers all relevant process steps / technologies over the supply chain of the represented cradle to gate inventory with a good overall data quality. Crude oil mix information based on official statistical information. Energy carrier extractio
Literature Reference	The data set is published in the ELCD database (1). The practitioner of the LCA is PE International (2) on behalf of JRC (3). (1) http://lca.jrc.ec.europa.eu/lcainfohub /datasetDownload.vm (2) PE International GmbH, Leinfelden-Echterdingen, Germany (the developer of the Gabi software and databases). (3) European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES). (4) SBPI, http://spbi.se /blog/faktadatabas/artiklar/berakningsmodeller/
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 42.3 MJ/kg (reference: ELCD database).	Input	Resource	Crude oil	2.62508462913018E-02			kg	Ground	
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 26.3 MJ/kg (reference: ELCD database).	Input	Resource	Hard coal	1.14994912440422E-04			kg	Ground	
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 11.9 MJ/kg (reference: ELCD database).	Input	Resource	Lignite	9.38041977354322E-05			kg	Ground	
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 44.1 MJ/kg (reference: ELCD database).	Input	Resource	Natural gas	1.43894052143549E-03			kg	Ground	
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 8.4 MJ/kg (reference: ELCD database).	Input	Resource	Peat	2.86622512854907E-06			kg	Ground	
	Input	Resource	Primary energy from geotermics	2.90568075117371E-05			MJ	Ground	
	Input	Resource	Primary energy from hydro power	1.31046478873239E-03			MJ	Ground	

	Input	Resource	Primary energy from solar energy	1.12728169014085E-04			MJ	Ground	
	Input	Resource	Primary energy from wind power	1.27431455399061E-04			MJ	Ground	
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 4.51E+05 MJ/kg (reference: Gabi database).	Input	Resource	Uranium	1.31978493280451E-08			kg	Ground	
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 14.7 MJ/kg (reference: ELCD database).	Input	Resource	Wood	1.99749289387116E-08			kg	Ground	
	Output	Emission	Ammonia	6.51213615023474E-08			kg	Water	
	Output	Emission	Ammonia	7.66715962441315E-08			kg	Air	
	Output	Emission	Benzene	3.09776995305164E-08			kg	Air	
	Output	Emission	Carbon dioxide (fossil)	7.0874882629108E-03			kg	Air	
	Output	Emission	Carbon monoxide	9.75896713615023E-06			kg	Air	
	Output	Emission	Hydrocarbons (unspecified)	9.11549295774648E-11			kg	Air	
	Output	Emission	Methane (fossil)	7.88713615023474E-05			kg	Air	
	Output	Emission	Nitrate (fresh water)	8.90892018779343E-09			kg	Water	
	Output	Emission	Nitrate (sea water)	2.03846713615023E-08			kg	Water	
	Output	Emission	Nitrogen monoxide	1.77394366197183E-13			kg	Air	
	Output	Emission	Nitrogen oxides	2.06153286384977E-05			kg	Air	
	Output	Emission	Nitrous oxide	1.63633802816901E-07			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	6.09546948356807E-06			kg	Air	
	Output	Emission	Particles (> PM10)	1.87520657276995E-14			kg	Air	
	Output	Emission	Particles (PM10)	4.61699530516432E-07			kg	Air	
	Output	Emission	Particles (PM2.5 - PM10)	3.31964788732394E-07			kg	Air	
	Output	Emission	Particles (PM2.5)	3.03849765258216E-07			kg	Air	
	Output	Emission	Phosphate	6.00676056338028E-08			kg	Water	
	Output	Emission	Sulfur dioxide	4.12272300469484E-05			kg	Air	
	Output	Product	Diesel EN590	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Felipe Oliveria, IVL.
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.

Notes	The original data were provided per kg and have been recalculated to per MJ fuel using a heat value of 42.6 MJ/kg (4). This heat value corresponds to diesel according to the EN590 standard. The original ELCD documentation is much more extensive than the documentation in the f3 project. The most important parts were included.

SPINE LCI dataset: Diesel engine, Euro 0

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Diesel engine, Euro 0
Functional Unit	kWh
Functional Unit Explanation	1 kWh mechanical work done by the engine
Process Type	Unit operation
Site	Sweden
Sector	Machinery and equipment
Owner	Sweden
Technical system description	Operation of a diesel engine, Euro 0, manufactured before 92 when environmental standards on emissions from diesel engines were not yet implemented.

System Boundaries	
Nature Boundary	Regulated emissions to air have been considered.
Time Boundary	The aim was that the data should represent engines manufactured before 1992, when there were no environmental standards for the emissions from diesel engines.
Geographical Boundary	The aim was that the data would represent engines manufactured in Sweden.
Other Boundaries	A specific test cycle on the engine (ECE R49) was used.
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1997-01-01
Data Type	Unspecified, expert outspoke
Represents	NTM
Method	The emissions were obtained by the ECE R49 test cycle. The energy use is based on assumptions on the efficiency of the engine. The fuel was assumed to be diesel environmental class 1. See specific QMetaData for each flow. Method description for NOx, HC, particles and CO can be found under NOx The quantity value for the fuel consumption refer to average efficiency of the engine, the maximum and minimum value refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For emissions of NOx, HC, particles and CO, the quantity

	value refer to an average engine guaranteed by Volvo Truck Corporation and the maximum value refer to voluntary European emission regulations for diesel engines before 1992.
Literature Reference	The data set is published in the ELCD database (1). The practitioner of the LCA is PE International (2) on behalf of JRC (3). (1) http://lca.jrc.ec.europa.eu/lcainfohub /datasetDownload.vm (2) PE International GmbH, Leinfelden-Echterdingen, Germany (the developer of the Gabi software and databases). (3) European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES). (4) SBPI, http://spbi.se /blog/faktadatabas/artiklar/berakningsmodeller/
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The fuel consumption is based on the efficiency of the engine. The quantity value refer to an average engine. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. **The following data was used in the calculations:** *Average efficiency of the engine:* 39 % *Change of efficiency of the engine due to degeneration:* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine The average efficiency and the change of efficiency is based on assumptions *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data was given by the Swedish Petroleum Institute.	Input	Refined resource	Diesel environmental class 1	213	211	215	g	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	1.5		12	g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission was calculated from the fuel consumption using the carbon content in the diesel. **The following data was used in the calculations:** *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l CO2 emission: 73 g/MJ fuel Sulphur content: 10 ppm The data was supplied by the Swedish Petroleum Institute.	Output	Emission	CO2	674	669	682	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	1.5		2.5	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions were obtained by a standardised test cycle, ECE R49 on the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to voluntary European emission regulations for diesel engines before 1992. No minimum value (except for NOx) was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high	Output	Emission	NOx	11	9	14	g	Air	

average engine load and high exhaust gas temperature.									
Method: See QMetaData for NOx	Output	Emission	Particles	0.4			g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission was calculated from the fuel consumption using the sulphur content in the diesel **The following data was used in the calculations:** *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data was supplied by the Swedish Petroleum Institute.	Output	Emission	SO2	0.0043	0.0042	0.0043	g	Air	
	Output	Product	Mechanical work	1			kWh	Technosphere	

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	
General Purpose	
Detailed Purpose	To obtain a basis to calculate energy use and emissions from different types of trucks.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	NGM reviewers: - Kjell Andersson, Naturvårdsverket; Håkan Johansson, Vägverket; Gunnar Kinbom, NUTEK; Magnus Lenner, VTI; Ann-Christin Pålsson, CPM/TMP
Applicability	The ECE R49 test cycle is intended to simulate long-distance driving conditions. The test cycle has been developed to create repeatable emission measurement conditions and, at the same time, simulate a real driving condition of a given application.
About Data	Data was obtained by test by the ECE R49 test cycle performed on the engine and assumptions on the efficiency of the engine
Notes	

SPINE LCI dataset: Diesel engine, Euro 1

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Diesel engine, Euro 1

Functional Unit	1 kWh
Functional Unit Explanation	1 kWh mechanical work done by the engine
Process Type	Unit operation
Site	
Sector	Machinery and equipment
Owner	
Technical system description	Operation of a diesel engine, Euro 1 environmental standard.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2.
Time Boundary	The aim was that the data should represent engines manufactured between 1992 and 1995. This corresponds to Euro 1 environmental standard for diesel engines.
Geographical Boundary	The aim was that the data would represent engines manufactured in Sweden.
Other Boundaries	A standardised test cycle on the engine (ECE R49) was used.
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were obtained by the ECE R49 test cycle. The energy use is based on assumptions on the efficiency of the engine. See specific QMetaData for each flow. Method description for NOx, HC, particles and CO can be found under NOx The quantity value for the energy use refer to average efficiency of the engine, the maximum and minimum value refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For emissions of NOx, HC, particles and CO, the quantity value refer to an average engine guaranteed by Volvo Truck Corporation and the maximum value refer to the emission regulations for diesel engines according to the emission standard Euro I.
Literature Reference	The data set is published in the ELCD database (1). The practitioner of the LCA is PE International (2) on behalf of JRC (3). (1) http://lca.jrc.ec.europa.eu/lcainfohub /datasetDownload.vm (2) PE International GmbH, Leinfelden-Echterdingen, Germany (the developer of the Gabi software and databases). (3) European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES). (4) SBPI, http://spbi.se /blog/faktadatabas/artiklar/berakningsmodeller/
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption was calculated using assumptions on the efficiency of the engine. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. **The following data was used in the calculations:** Average efficiency of the engine: 40% < p>*Change of efficiency of the engine:* -minimum value: 0,99 in relation	Input	Refined resource	Diesel environmental class 1	207	205	209	g	Technosphere	

to the average engine -maximum value:1,01 in relation to the average engine The average efficiency and the change of efficiency is based on assumptions *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data was given by the Swedish Petroleum Institute.									
Method: See QMetaData for NOx.	Output	Emission	CO	1		4.5	g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission was calculated from the fuel consumption using the carbon content in the diesel. **The following data was used in the calculations:** *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l CO2 emission: 73 g/MJ fuel Sulphur content: 10 ppm The data was supplied by the Swedish Petroleum Institute.	Output	Emission	CO2	657	650	663	g	Air	
Method: See QMetaData for NOx.	Output	Emission	HC	0.5		1.1	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions were obtained by a standardised test cycle, ECE R49 on the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to emission regulations for diesel engines according to the emission standard Euro I. No minimum value was given. The quantity value was given by Volvo Truck Corporation. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature.	Output	Emission	NOx	7.6		8	g	Air	
Method: See QMetaData for NOx.	Output	Emission	Particles	0.2		0.36	g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission was calculated from the fuel consumption using the sulphur content in the diesel **The following data was used in the calculations:** *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data was supplied by the Swedish Petroleum Institute.	Output	Emission	SO2	0.0041	0.0041	0.0042	g	Air	
	Output	Product	Mechanical work	1			kWh	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --

Intended User	
General Purpose	
Detailed Purpose	The data was compiled to obtain a basis to calculate energy use and emissions from different types of trucks.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	NGM reviewers: - Kjell Andersson, Naturvårdsverket; Håkan Johansson, Vägverket; Gunnar Kinbom, NUTEK; Magnus Lenner, VTI; Ann-Christin Pålsson, CPM/TMP
Applicability	
About Data	
Notes	The data was used as a basis to calculate the energy use and emissions for different types of trucks in the work of NGM published in Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997, NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997

SPINE LCI dataset: Diesel engine, Euro 2

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Diesel engine, Euro 2
Functional Unit	1 kWh
Functional Unit Explanation	1 kWh mechanical work done by the engine
Process Type	Unit operation
Site	
Sector	Machinery and equipment
Owner	
Technical system description	Operation of a diesel engine, Euro 2 environmental standard.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2.
Time Boundary	The aim was that the data should represent engines manufactured after 1996. This corresponds to Euro 2 environmental standard for diesel engines.
Geographical Boundary	The aim was that the data would represent engines manufactured in Sweden.
Other Boundaries	A standardised test cycle on the engine (ECE R49) was used.
Allocations	N/A

Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were obtained by the ECE R49 test cycle. The energy use is based on assumptions on the efficiency of the engine. See specific QMetaData for each flow. Method description for NOx, HC, particles and CO can be found under NOx The quantity value for the energy use refer to average fuel consumption, the maximum and minimum value refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For emissions of NOx, HC, particles and CO, the quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to an engine run 500 000 km. No minimum value was given.
Literature Reference	The data set is published in the ELCD database (1). The practitioner of the LCA is PE International (2) on behalf of JRC (3). (1) http://lca.jrc.ec.europa.eu/lcainfohub /datasetDownload.vm (2) PE International GmbH, Leinfelden-Echterdingen, Germany (the developer of the Gabi software and databases). (3) European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES). (4) SBPI, http://spbi.se /blog/faktadatabas/artiklar/berakningsmodeller/
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption was calculated using assumptions on the efficiency of the engine. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. **The following data was used in the calculations:** Average efficiency of the engine: 41 % *Change of efficiency of the engine:* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine The average efficiency and the change of efficiency is based on assumptions *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data was given by the Swedish Petroleum Institute.	Input	Refined resource	Diesel environmental class 1	202	199	205	g	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.7		0.8	g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission was calculated from the fuel consumption using the carbon content in the diesel. **The following data was used in the calculations:** *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l CO2 emission: 73 g/MJ fuel Sulphur content: 10 ppm The data was supplied by the Swedish Petroleum Institute.	Output	Emission	CO2	640	631	650	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.4		0.42	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions were obtained by a standardised test cycle, ECE R49 on the engine. The	Output	Emission	NOx	6.3		6.3	g	Air	

quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refers to an engine run 500 000 km. No minimum value was given. The data was given by Volvo Truck Corporation. **The following data was used in the calculations:** *The maximum value i.e. engine run 500 000 km* is based on special degeneration factor tests for EPA/CARB on 12 litre engines. The tests were performed on four engines run 470 000 km. An average of the tests was used to calculate the percentage degeneration in emissions in relation to the average engine. The following degeneration factors was used: NOx 1,5 % degeneration in relation to the average engine HC 4 % degeneration in relation to the average engine CO 20 % degeneration in relation to the average engine Particles 2 % degeneration in relation to the average engine *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature.									
Method: See QMetaData for NOx	Output	Emission	Particles	0.11		0.11	g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission was calculated from the fuel consumption using the sulphur content in the diesel **The following data was used in the calculations:** *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data was supplied by the Swedish Petroleum Institute.	Output	Emission	SO2	0.004	0.004	0.0041	g	Air	
	Output	Product	Mechanical work	1			kWh	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	
General Purpose	
Detailed Purpose	The data was compiled to obtain a basis to calculate energy use and emissions for different types of trucks.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	NGM reviewers: - Kjell Andersson, Naturvårdsverket; Håkan Johansson, Vägverket; Gunnar Kinbom, NUTEK; Magnus Lenner, VTI; Ann-Christin Pålsson, CPM/TMP
Applicability	
About Data	

Notes	

SPINE LCI dataset: Diesel engine, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Diesel engine, future
Functional Unit	1 kWh
Functional Unit Explanation	1 kWh mechanical work done by the engine.
Process Type	Unit operation
Site	Sweden
Sector	Machinery and equipment
Owner	Sweden
Technical system description	Operation of a diesel engine representing the proposed Euro 3 environmental standard.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2.
Time Boundary	The aim was that the data should represent the best available technology, not yet in use (proposed Euro 3 environmental standard).
Geographical Boundary	The aim was that the data would represent engines manufactured in Sweden.
Other Boundaries	A specific test cycle was used. The test cycle is proposed for standardisation.
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1996-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The data was obtained by tests performed on the engine by a new test cycle. The energy use is based on the efficiency of the engine. The fuel was assumed to be diesel environmental class 1. See specific QMetaData for each flow. Method description for NOx, HC, particles and CO can be found under NOx .
Literature Reference	The data set is published in the ELCD database (1). The practitioner of the LCA is PE International (2) on behalf of JRC (3). (1) http://lca.jrc.ec.europa.eu/lcainfohub /datasetDownload.vm (2) PE International GmbH, Leinfelden-Echterdingen, Germany (the developer of the Gabi software and databases). (3) European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES). (4) SBPI, http://spbi.se

	/blog/faktadatabas/artiklar/berakningsmodeller/
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 96-01-01 - 97-11-19 Data type: Derived, unspecified Method: The fuel consumption is based on the efficiency of the engine (Ahlvik). **The following data was used in the calculations:** *Average efficiency of the engine:* 43 % *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data was given by the Swedish Petroleum Institute.	Input	Refined resource	Diesel environmental class 1	193			g	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.1			g	Air	
Date concieved: 96-01-01 - 97-11-19 Data type: Derived, unspecified Method: The emission was calculated from the fuel consumption using the carbon content in the diesel. **The following data was used in the calculations:** *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l CO2 emission: 73 g/MJ fuel Sulphur content: 10 ppm The data was supplied by the Swedish Petroleum Institute.	Output	Emission	CO2	611			g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.1			g	Air	
Date concieved: 96-04-01 - 97-11-19 Data type: Single sample Method: The emissions was obtained by a new test cycle on the engine. The data can be found in Ahlvik et al.	Output	Emission	NOx	5			g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.02			g	Air	
Date concieved: 96-01-01 - 97-11-19 Data type: Derived, unspecified Method: The emission was calculated from the fuel consumption using the sulphur content in the diesel **The following data was used in the calculations:** *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data was supplied by the Swedish Petroleum Institute.	Output	Emission	SO2	0.0039			g	Air	
Date concieved: 96-04-01 - 97-11-19	Output	Product	Mechanical work	1			kWh	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 --- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	
General Purpose	
Detailed Purpose	The data was compiled to obtain a basis to calculate energy use and emissions for different types of trucks.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	NGM reviewers: - Kjell Andersson, Naturvårdsverket; Håkan Johansson, Vägverket; Gunnar Kinbom, NUTEK; Magnus Lenner, VTI; Ann-Christin Pålsson, CPM/TMP
Applicability	

About Data	The data is based on a specific test cycle on the engine.
Notes	

SPINE LCI dataset: Diesel MK1, cradle-to-gate, energy allocation - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Diesel MK1, cradle-to-gate, energy allocation - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of diesel MK1
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	There are two data sources for diesel production, which have been considered to be the best available data to be published in the f3 project; data from an LCA for diesel produced in Sweden (Öman 2011) and data from the ELCD database. For Swedish MK1 diesel the data from Öman 2011 have been chosen and for the diesel according to the EN590 standard, the ELCD data were applied. When looking at the GWP for instance, the data applied for MK1 is 27 % lower than the ELCD data applied for EN590. The study comprises, within its system boundary, the extraction of crude oil, transport from the extraction site to the refinery, production of petroleum products at the refinery, transport from the refinery to oil depots, storage at depots, as well as distribution from depots to customer/gas station, for 1 MJ of diesel. The LCI is based mostly on the conditions of the diesel designed to be sold in the Swedish market in 2009. For example, the crude oil used to produce this diesel is identified by its origin. Inputs and outputs in the refining process (amount of crude oil, electricity consumption and emissions) have been allocated according the energy content of products and calculated as an average of three refineries (of a total of 6), which provide the Swedish market with diesel. The study also includes the mapping of the distribution of diesel through different means of transport, from refinery to depot/customer, for the six refineries mentioned above. The electricity consumed during the life cycle (refining process, at storage, railroad transportation) is assumed to be based on the Swedish electricity mix in a supply perspective, i.e. the environmental impacts are calculated based on the consumed electricity, not produced.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Sweden
Other Boundaries	
Allocations	Inputs and outputs in the refining process (amount of crude oil, electricity consumption and emissions) have been allocated according the energy content of products.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	NTM
Method	Literature studies. See also technical system description.
Literature Reference	Gode, J. et al., 2011, Miljöfaktaboken 2011, Uppskattade emissionsfaktorer för bränslen, el, värme och transporter, Värmeforsk. Data in Gode et al. are based on: Öman Andreas, Hallberg Lisa, Rydberg Tomas (2011). LCI för petroleumprodukter som används i Sverige. IVL rapport B1965. 2011. Some recalculations were made based on heat values from the Gabi database. The Gabi LCA software and databases are developed by PE International GmbH, Leinfelden-Echterdingen, Germany.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 42.3 MJ/kg (reference: Gabi database).	Input	Resource	Crude oil	0.024822695035461			kg	Ground	
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 26.3 MJ/kg (reference: Gabi database).	Input	Resource	Hard coal	4.48669201520913E-05			kg	Ground	
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 11.9 MJ/kg (reference: Gabi database).	Input	Resource	Lignite	2.78991596638655E-05			kg	Ground	
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 44.1 MJ/kg (reference: Gabi database).	Input	Resource	Natural gas	6.16780045351474E-04			kg	Ground	
	Input	Resource	Primary energy from biomass	0.000000123			MJ	Ground	
	Input	Resource	Primary energy from hydro power	0.00566			MJ	Ground	
	Input	Resource	Primary energy from solar energy	0.0000322			MJ	Ground	
	Input	Resource	Primary energy from solar energy	0.0000703			MJ	Ground	
Notes: Originally provided as MJ. Recalculated to kg by using the heat value 4.51E+05 MJ/kg (reference: Gabi database).	Input	Resource	Uranium	1.48115299334812E-08			kg	Ground	
	Output	Emission	Ammonia	0.0000000000166			kg	Water	
	Output	Emission	Ammonia	0.0000000125			kg	Air	
	Output	Emission	Ammonium	0.0000000254			kg	Water	
	Output	Emission	Carbon dioxide (fossil)	0.00578			kg	Air	
	Output	Emission	Carbon monoxide	0.0000046			kg	Air	
	Output	Emission	Methane (fossil)	0.0000338			kg	Air	
	Output	Emission	Nitrate	0.0000000271			kg	Water	
	Output	Emission	Nitrogen oxides	0.0000188			kg	Air	
	Output	Emission	Nitrous oxide	0.0000000555			kg	Air	

	Output	Emission	Non-methane volatile organic compounds	0.0000235			kg	Air	
	Output	Emission	Particles (unspecified)	0.000000848			kg	Air	
	Output	Emission	Phosphate	0.000000000317			kg	Water	
	Output	Emission	Sulfur dioxide	0.0000141			kg	Air	
	Output	Product	Diesel MK1	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Hallberg, IVL.
Reviewer	-
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Diesel production

Administrative	
Finished	Y
Date Completed	1996-01-01
Copyright	
Availability	Public

Technical System	
Name	Diesel production
Functional Unit	MJ
Functional Unit Explanation	Per MJ diesel fuel ready for combustion in an engine.
Process Type	Cradle to gate
Site	North Sea
Sector	Fuel
Owner	North Sea
Technical system description	The data include emissions from energy use as well as specific process emissions for crude oil extracted in the North Sea.. The emissions from extraction, transport and refining of the raw energy carrier natural gas are not included.

System Boundaries

Nature Boundary	Emissions to air and water from the activities producing diesel fuel from crude oil are included (extraction, transport & refining). Emissions caused by the use of crude natural gas are neglected.
Time Boundary	All data refer to 1992.
Geographical Boundary	The crude oil is taken from the North Sea. Where it is transported to and where the refining takes place is not stated in the source.
Other Boundaries	N/A
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1992-01-01
Data Type	Unspecified
Represents	NTM
Method	This activity includes extraction, transportation and refinment of diesel fuel from North Sea crude oil. Some crude natural oil is also used, but not included in the study.
Literature Reference	1. Life of Fuels Ecotraffic AB, Stockholm, Sweden, 1992 2. Tillman et al. Packaging and the environmnet, CIT,Sweden, 1992 Summarized by Lisa Person at CIT, Chalmers Industri Teknik in January 1996.
Notes	The heat value for diesel is 42,7 MJ/kg

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Crude natural gas	0.58			g	Ground	North Sea
	Input	Natural resource	Crude oil	25.1			g	Ground	North Sea
	Output	Emission	CH4	0.028			g	Air	Sweden
	Output	Emission	CO	0.008			g	Air	Sweden
	Output	Emission	CO2	10.4			g	Air	Sweden
	Output	Emission	COD	0.00117			g	Water	Sweden
	Output	Emission	HC	0.014			g	Air	Sweden
	Output	Emission	N2O	0.0045			g	Air	Sweden
	Output	Emission	NOx	0.044			g	Air	Sweden
	Output	Emission	N-tot	0.000191			g	Water	Sweden
	Output	Emission	Oil	0.0004			g	Water	Sweden
	Output	Emission	Particulates	0.0004			g	Air	Sweden
	Output	Emission	Phenol	0.0000057			g	Water	Sweden
	Output	Emission	SO2	0.021			g	Air	Sweden
	Output	Product	Diesel	1			MJ	Technosphere	Sweden

About Inventory

Publication	Birgit Backlund et al. Use of agro fibre for paper production from an environmental point of view, Nordpap DP 2/54, Scan forskrapport 682, oktober 1997. --- Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	LCA practitioners
General Purpose	The purpose is to supply with LCA-data for diesel fuels used in forestry to be a part of further studies of wood products.
Detailed Purpose	These data were published in ''Use of agro fibre for paper production from an environmental point of view, Backlung et al. Nordpap DP 2/54 Scan Forskrapport, 1997''.
Commissioner	
Practitioner	Person, Lisa - Chalmers Industri Teknik .
Reviewer	

Applicability	This activity generates diesel fuel from mainly crude oil. It´s emissions origin from extraction, transport and refining. The product (diesel fuel) must be put in to another activity, where the fuel is combusted, generating energy.
About Data	
Notes	

SPINE LCI dataset: Diesel propulsed train

Administrative	
Finished	Y
Date Completed	1999 - 11
Copyright	NTM
Availability	The data is publically available.

Technical System	
Name	Diesel propulsed train
Functional Unit	1 tonkm , 55 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 55 %. An utilisation level of 55 % is representative for Swedish domestic traffic if transportation of empty waggons etc. are included.
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation i.e. propultion of freight train with a diesel-driven T44 engine. Diesel engines are mainly used for shunting and regular traffic in sections where there is no areal line. Maximum gross weight of the train: 1200 tonnes. Maximum available loading capacity with regard to weight 972 tonnes.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: - Regulated emissions for diesel engines: NOx, HC, particles and CO - Fuel regulated: SO2 - Tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data are representative for diesel powered trains in use 1999.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 55 %. The utilisation level includes transportation of empty waggons and cars. Not included in the system Production and maintenence of the tracks. Driving technique External conditions, i.e., road conditions, climate etc. Maintenance level of the engine
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1999 - 06
Data Type	Random samples
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with the assumptions on the fuel consumption, type of fuel used (diesel environmental class 1) and utilisation level (55%). The emissions per tonkm were calculated using emission factors (g/kWh) obtained by a standardised test cycle, ECE R49 on the engine, where kWh refers to mechanical work done by the engine. The tests was performed by Motortestcenter. ***The following data was used in the calculations:*** *Assumptions given by the Swedish State Railways:* -Average fuel consumption: 3,5 l/km. -Utilisation level: 55 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 3 (given by the Swedish Petroleum Institute):* -Thermal value: 9,952 kWh/l -Density: 0,820-0,860 kg/l -Sulphur content: 500 ppm *The emission factors were :* -NOx 19,4 g/kWh -HC 0,77 g/kWh -CO 1,27 g/kWh -Particles 0,51 g/kWh The data is found in ''Exhaust emission from a two stroke lokomotive engine''. The ECE R49 is a steady state cycle for heavy duty truck engines. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature.
Literature Reference	Exhaust emissions from a two stroke locomotive engine, MTC rapport 96:4, Motortestcenter, Svensk Bilprovning, 1996
Notes	The heat value for diesel is 42,7 MJ/kg

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel	0.234			MJ	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.019			g	Air	Sweden
	Output	Emission	CO2	17			g	Air	Sweden
	Output	Emission	HC	0.015			g	Air	Sweden
	Output	Emission	NOx	0.35			g	Air	Sweden
	Output	Emission	SO2	0.000054			g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data Documented by Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value

	since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM .
Practitioner	Strömberg, Jonas - SJ Cargo Group, Stockholm .
Reviewer	
Applicability	The data should not be used for detailed studies of transportation activities. More detailed data is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information in these matters. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used. Electrically driven trains transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transported by combi trains are about 5 % of the total amount of goods transported by electrically driven trains. Electyrically driven system trains are not recoupled on the way and always take the same route between two adresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is about 50 % or higher. System trains ordinarily runs special transportation assignments for different types of industry. Diesel driven engines (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the swedish railway system that are not electrified. SJ also uses smaller diesel engines (V5) for shunting. The V5 engine has a capacity of 400-500 tonnes gross weight and is not used for regular traffic. -- Marshalling -- The major part of the goods is marshalled at 6 main junctions where the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (valväxling) -Fly shunting (planväxling) -- Distance-- The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ has developed an environmentl data software with a databas of distances between 70 different places, concidering the infrastructure. The database does however not give information on which lines that arenot electrified. -- Bulky goods-- The data can be used for bulcy goods with the recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.
About Data	Locomotive: T44 Fuel: MK-1 Estimated loading: 535 tonnes. Fuel consumption: 3,5l/km. Sulpher in fuel: 100 ppm weight. Used testcycle: ECE R49. The data is based on tests on one lokomotive engine performed in a laboratory. This means that several parameters that influence the energy use and emissions in regular traffic are not concidered, e.g., climate, topography, driving technique, maintenance etc. Since the emissions depend on the engine speed and local conditions the emissions in actual operation may vary substatually. The test cycle was developed to represent long-distance traffic. The data is based on an average utilisation level of 55 %, based on statistics from 1993 from the Swedish State Railways (SJ). Today the average utilisation level is higher according to SJ due to different actions to use the trains more effective, and it is not possible to discern a difference in utilisation between electrically driven and diesel driven freight trains.
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by train in NTM. Data is collected from NTM homepage, latest updated 1999 - 11 - 11. The data is continously updated and the user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: www.ntm.a.se

	The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation.Updated data for diesel trains and road transport are expected to be published before summer 2000. The major Swedish actors in the transportation business, which are members of NTM (e.g., SJ, BTL, ASG, etc.), will use the data as a basis for environmental assessment of different transportation alternatives.

SPINE LCI dataset: Dioctyl phthalate (DOP) production. ESA-DBP

Administrative	
Finished	Y
Date Completed	1992
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Dioctyl phthalate (DOP) production. ESA-DBP
Functional Unit	1 kg of dioctyl phthalate (DOP)
Functional Unit Explanation	Not applicable.
Process Type	Gate to gate
Site	Neste Oxo ABStenungsund
Sector	Materials and components
Owner	Neste Oxo ABStenungsund
Technical system description	DOP is produced through a number of reactions, in which orthoxylene, fuel oil and propylene are the main raw materials. DOP is the dominant plasticizer used in PVC. This process is included in the system described in: Jönsson Å, 1995, Life cycle assessment of flooring materials - a case study and methodological considerations. Licentiate thesis. Technical Enviroinmental Planning report 1995:3, Technical Environmental Planning, Chalmers University of Technology, Göteborg, Sweden Other processes in the CPM Database connected to the above publication: Linoleum flooring. ESA-DBP Vinyl flooring. ESA-DBP Solid wood flooring. ESA-DBP

System Boundaries	
Nature Boundary	Emissions to air inlcludes emissions from fuels.
Time Boundary	Data from Environmental Report in 1992.
Geographical Boundary	Data from Environmental Report from Neste Oxo AB in Stenungsund, Sweden.
Other Boundaries	Excerpt from the report (see 'Publication'): ''The production of phthalic anhydride occurs elsewhere but is included in the data given below, including transportation between phthalic anhydride production and plasticiser production.''
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data
General Activity QMetaData

Date Conceived	1992
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	Data from Environmental Report.
Literature Reference	Miljörapport 1992 (1992 Environmental Report) Neste Oxo AB, Stenungsund., Sweden
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Diesel oil (transportation).	Input	Refined resource	Diesel	0.05			MJ	Technosphere	
	Input	Refined resource	Electricity	1.8			MJ	Technosphere	
	Input	Refined resource	Fuel oil	11.2			MJ	Technosphere	
Notes: Fuel oil 5.	Input	Refined resource	Fuel oil	171			g	Technosphere	
	Input	Refined resource	orthoxylene	355			g	Technosphere	
	Input	Refined resource	Propylene	500			g	Technosphere	
	Output	Emission	CO	0.03			g	Air	
	Output	Emission	CO2	691			g	Air	
	Output	Emission	COD	0.17			g	Water	
	Output	Emission	Dust	0.02			g	Air	
	Output	Emission	NO2	0.27			g	Air	
	Output	Emission	SO2	0.09			g	Air	
	Output	Emission	VOC	0.26			g	Air	
	Output	Product	dioctyl phthalate	1			kg	Technosphere	
	Output	Residue	Hazardous waste	13.5			g	Technosphere	

About Inventory

Publication	Jönsson Å, 1995, Life cycle assessment of flooring materials - a case study and methodological considerations. Licentiate thesis. Technical Enviroinmental Planning report 1995:3, Technical Environmental Planning, Chalmers University of Technology, Göteborg, Sweden
Intended User	LCA practitioners.
General Purpose	This data set is included in the system described in a Licentiate thesis.
Detailed Purpose	Excerpt from the Licentiate thesis (see 'Publication') where this data set i included: ''The objectives and scope of this thesis are to assess what methodological LCA (Life Cycle Assessment) questions are specific to buildings and building materials, to compare LCA with other environmental assessment methods that may be applied to building materials, and to describe what environmental problems are associated with buildings and building materials. A literature study categorises and describes what information exists in the fields of environmental assessment of buildings and building materials, and for what purpose it is utilised.''
Commissioner	Not applicable - .
Practitioner	Jönsson, Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden .
Reviewer	Tillman, Anne-Marie - Environmental Systems Analysis
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-09-15 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Dioctyl phthalate (DOP) production. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Dioctyl phthalate (DOP) production. ESA-DBP
Functional Unit	1 kg of DOP
Functional Unit Explanation	DOP- Dioctyl phthalate
Process Type	Gate to gate
Site	Neste Oxo AB, Stenungsund, Sweden
Sector	Chemicals and chemical products
Owner	Neste Oxo AB, Stenungsund, Sweden
Technical system description	(NB: the flowchart can be found in the reference report) Excerpt from the report, see 'Publication': ''DOP is a standard chemical product used KWH to adjust the softness of their products. (...) Refinery products are products such as naphtha and propane from the cracking process. The refinery have a multiple output of several products of which three are used is the production of DOP. (...) DOP is produced through a number of reactions in which propylene, fuel oil and orthoxylene are the main raw materials.'' This process is included in the system described in: Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Manufacturing of CD-R (Compact Disc-Recordable). ESA-DBP - Manufacturing of CD-ROM (Compact Disc - Read Only Memory). ESA-DBP - Cultivation and felling of trees for papermaking. ESA-DBP - Cardboard production (MDF based). ESA-DBP - Production of copypaper. ESA-DBP - Production of orthoxylene. ESA-DBP

System Boundaries	
Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials), emissions to air and water.
Time Boundary	1995
Geographical Boundary	Sweden
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''The data are taken from Jönsson (1995) where the data are taken from the production of DOP at Neste Oxo AB in Stenungsund.''
Literature Reference	Jönsson, Å. Life Cycle Assessment of Flooring Materials. Göteborg: Chalmers University of Technology. Technical Environmental Planning, 1995:3
Notes	NB: Flowchart is shown is in the reference report.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Diesel	5.00E-02			g	Technosphere	Sweden
	Input	Refined resource	Electricity	1.80E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Fuel oil	1.12E+01			g	Technosphere	Sweden
	Input	Refined resource	Fuel oil 5	1.71E+02			g	Technosphere	Sweden
	Input	Refined resource	Orthoxylene	3.55E+02			g	Technosphere	Sweden
	Input	Refined resource	Propylene	5.00E+02			g	Technosphere	Sweden
	Output	Emission	CO	3.00E-02			g	Air	Sweden
	Output	Emission	CO2	6.91E+02			g	Air	Sweden
	Output	Emission	COD	1.70E-01			g	Water	Sweden
	Output	Emission	Dust	2.00E-02			g	Air	Sweden
	Output	Emission	NOx	2.70E-01			g	Air	Sweden
	Output	Emission	SO2	9.00E-02			g	Air	Sweden
	Output	Emission	VOC	2.60E-01			g	Air	Sweden
	Output	Product	DOP	1.00E+00			kg	Technosphere	Sweden
	Output	Residue	Hazardous waste	1.35E+01			g	Technosphere	Sweden

About Inventory

Publication	Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	The study was done for the purpose of master thesis.
Detailed Purpose	Excerpt from the report: ''The goal of this study is to undertake an life cycle assessment (LCA) of different alternatives for Ericsson to provide their customers with reference libraries to the Ericsson Consolo MD110 telephone exchange system. The different documentation alternatives investigated in this study are: plastic ring binders, paperbacks, CD-R records and CD-ROM records.''
Commissioner	Ericsson, Stockholm, Sweden - .
Practitioner	Torsten Beckman - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The inventory results for the whole life cycle (from cradle to grave) of binders, paperbacks, CD-Rs and CD-ROMs can be found in the reference report.

SPINE LCI dataset: Diode wafer production and assembly

Administrative	
Finished	Y
Date Completed	2000-03-02
Copyright	Ericsson
Availability	Official

Technical System	
Name	Diode wafer production and assembly
Functional Unit	One gram of diode with capsule type DO-214AA
Functional Unit Explanation	The motivation for choosing this functional unit is: · suitable unit to work with in an LCA of a private branch exchange (a complicated telecom product) · important component of the MD110 product system and many other electronic products. DESIGN The answers from component manufacturer one (CM1), component manufacturer two (CM2) and component manufacturer three (CM3) are for three different components but they all have they same capsule type, the DO-214AA. These facts are based on Ericsson technical specification of the component. Product specifications: CM1: Ericsson product number: RKZ 323 313/7 Ericsson description: Bidirectional breakdown diode, General: Bidirectional transient voltage suppressor designed to protect sensitive components. The suppressor is a clamping type with zener voltage 6,8 V to 150V and peak pulse dissipation is 600W Design general: moulded plastic similar to JEDEC DO-214AA. Intended for surface mounting. Dimensions: Height: 2,0-2,6 mm, Length: 5,1-5,6 mm, Width: 3,3-3,95 mm, Terminal thickness: 0,1-0,3 mm Weight: 0,087 g CM2 Ericsson product number: RKZ 323 312/1 Ericsson description: Schottsky diode 90V 0,77A General: The schottsky rectifier diode is for applications requiring low forward drop and small footprints. Design general: The case is D-64, inteded for surface mounting. Dimensions: Height: 1,8-2,4 mm, Length: 4,7-5,5 mm, Width: 2,3-2,8 mm, Terminal thickness: 0,9-1,6 mm Weight: 0,064 g CM3 Ericsson product number: RKZ 323 316/1 Ericsson description: Thyristor diode, transient voltage suppressor, bidirectional General: Bidirectional thyristor diode designed for subscriber line-card and terminal protection. Design general: Plastic case with tinned terminals intended for surface mounting on printed circuit board. Case: SOD 6 similary to DO-214AA. Dimensions: Height: 2,0-2,6 mm, Length: 2,61 mm, Width: 3,93 mm, Terminal thickness: 0,2 mm Weight: 0,181 g
Process Type	Gate to gate

Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the diode wafer production and the final assembly of diodes with capsule type DO-214AA. The activity is an average based on information acquired from three manufacturers. The description of the process is supplied by manufacturer two, but is assumed to be general for this type of manufacture. The following process steps are included; Wafer factory: 1. Wafer preclean and oxidation 2. Ring masking 3. Mask etching 4. Ring doping 5. Ring oxidising 6. Mask to open active area 7. Etch oxide in active area 8. Deposition of barrier metal 9. Deposition of contact metal 10. Mask & Etch of back side for contact metal 11. Back side metal deposition 12. Probing Shipping to assembly plant. Assembly factory: 1. Wafer sawing 2. Silicon die bonding & soldering 3. Moulding & de-flashing 4. Trimming and forming 5. Testing & marking 6. Packing No detailed description was given by any of manufacturers. Additional information: Below are some additional information supplied by each of the included component manufacturers. --Component manufacturer one -- CM1 constitute a wafer fabrication unit front-end with a backend assembly area for the manufacture of Diodes, Transient Voltage Suppressors and Bridge Rectifiers. Component manufacturer one (CM1) specifies that 650000 units are produced equaling 57000 grams. The silicon die for the diode is produced inside the factory. Resource raw material quantities used in the manufacturing of the silicon die are small or supplied locally. The plant has a capacity to manufacture over 100 million units per month. Approximately 60% of all solid waste is recycled including all cardboard packaging. All emission data is taken from measurements from site emission points. All wastewater is treated on site by either primary or tertiary treatment and then discharged to sewer for further secondary treatment. All acid and other aqueous wastes including metal contaminated wastewater are treated in two wastewater treatment plants on site. The wastewater treatment is included in the activity. Initiatives have been successfully completed in water conservation with a 15% reduction in 1998; future projects are at an advanced stage including membrane technology utilisation to reduce water consumption by the recovery of wastewater allowing a 30% reduction in wastewater generation. Approximately 60 % of all solid waste from the facility is recovered and recycled or reused. Wastewater treatment plant sludge Non Toxic, Non Hazardous (As per the European waste catalogue and analysis completed) at 55% solids is reused as a landfill capping agent. N-Butyl Acetate, Xylene and W.N.R.D solvent wastes are recovered and reused as paint thinners. All other Hazardous waste is incinerated at (CM1) audited and accepted facilities. The reuse of sludge in incineration is not included. -- Component manufacturer two -- For component manufacturer two (CM2), the wafer factory is located in Malaysia and the assembly factory is located in Italy. The transport between the two factories is included in the data supplied by the manufacturer. Component manufacturer two (CM2) specifies that their transport figures are referred to the Wafer plant. The assembly data are not available, and thus not included for this manufacturer. Transport by road has been estimated by

	looking at maps. CM2 describes their plants as Class 1000 Wafer Fab and Class 10000 assembly and final test Facility. CM2 describes furthermore that the studied product is a Surface Mounting Schottky diode encapsulated in SMA. The Schottky barrier is formed by the deposition of barrier metal on n-epi silicon. It is at this interface that the rectifying contact is created. This type of metal to semiconductor contact allows for a lower forward voltage drop as compared to a diffused pn junction diode. The Schottky diodes incorporate a guard ring structure that is located at the perimeter of the die surface. This structure consists of a diffused p-well in the n-epi layer located at the semiconductor-oxide metal interface region. The p-type guard ring reduces the electrical field strength by injecting minority carriers into the n-epi layer. This structure is effecting a reverse biased pn avalanche junction used to protect the Schottky barrier from excessive voltage stress. The anode metallization consists of Ti, Ni, and Ag for solder attachment. The cathode metallization also consists of Ti, Ni, and Ag to create an ohmic contact with the n++ silicon substrate. This process step is some of the steps 8-12 in the Wafer factory. The cathode and anode side of the silicon die is soldered respectively to the relevant lead frame using a reflow soldering technique. After die attach the lead frame is encapsulated with an Epoxy resin compound followed by a curing period. A trimming operation followed by a lead forming and a Plating process is performed before the electrical final test. Marking and packing are the last two operations. The energy-ware, emissions and waste data are referred to the Wafer plant. The assembly data are not available. --Component manufacturer three -- Component manufacturer three (CM3) specifies that their annual production is 3,600,000 pieces. The silicon is purchased as a wafer. The die is manufactured on site. Emissions to air are via ion exchange filters located within system. All emissions to water are processed via the effluent system, located on site. Very little is sent to effluent system, as a filter system is in place. CM3 found it not possible to calculate emissions and waste per functional unit.

System Boundaries

Nature Boundary	The emissions to air and water have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No arameter has deliberately been disregarded when environmental impact has been studied. Included component manufacturers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used.
Time Boundary	1998 The answer from the manufacturer arrived in 1998 and they measured in 1998. The process technology used is most certainly the best available as the factories are located in Ireland, Italy, Malaysia and England and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The model is made up of answers from three component manufacturers, one from Ireland, one from Italy/Malaysia and one from England.
Other Boundaries	Delimitations to the system is the wafer fabrication and the final assembly step in the making of the diode. The production of the subparts (e.g. Epoxy resin, Solder paste, Copper lead wire and leadframe) of the diode is not included in this model The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	See 'Function'

Method	The data that are presented are calculated as a average based on information from three component manufacturers. The information from the manufacturers was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers In the information supplied by the manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+..+.ACn Step 2: The sum AC11+..+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to three answers was made.
Literature Reference	Jönsson, Å. Life Cycle Assessment of Flooring Materials. Göteborg: Chalmers University of Technology. Technical Environmental Planning, 1995:3
Notes	Component manufacturer one, CM1: WAFER FAB + ASSEMBLY, IRELAND Component manufacturer two, CM2: WAFER FAB: ITALY, ASSEMBLY, MALAYSIA Component manufacturer three, CM3: WAFER FAB + ASSEMBLY, ENGLAND

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 0,001 dm3 for 1000 diodes. One diode weighs 0,0877 grams. According to http://www.chemfinder.com /cgi-win/cfserver.exe/ Butyl Carbitol is the same substance as 2-(2-Butoxyethoxy)ethanol and the specific gravity is 0,967 kg/dm3. Hence, 0,001 * 0,967 / 0,0877 = 0,011 g 2-(2-Butoxyethoxy)ethanol /g diode This is not an average value and the figure is based only on one answer. Literature: Notes: 112-34-5 is the CAS-number for 2-(2-Butoxyethoxy)ethanol	Input	Refined resource	2-(2-Butoxyethoxy)ethanol	0.01			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 3 states they use 6 mg for a diode which weighs 0,181 g. Hence, 0,006 / 0,181 = 0,033 g This is not an average value and the figure is based only on one answer. Notes: 64-19-7 is the CAS-number for acetic acid	Input	Refined resource	Acetic Acid	0.03			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0.006 mg/64 mg = 9.375e-5 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Ag	9.375E-05			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM3: 10 mg /181 mg = 0,055 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Au	0.055			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 0,087 dm3 for 1000 diodes. One diode weighs 0,0877 grams. According to http://www.chemfinder.com /cgi-win/cfserver.exe/ Butyl	Input	Refined resource	Butyl acetate	0.06			g	Technosphere	

Acetate has a specific gravity of 0,882 kg/dm3. Hence, 0,882 * 0,087 / 0,0877 = 0,0875 g Butyl Acetate The answer from component manufacturer 3 states they use 6 mg for a diode which weighs 0,181 g. Hence, 0,006 / 0,181 = 0,033 g Butyl Acetate Average value (0,0875 + 0,033)/2 = 0,06025 g Butyl Acetate This is an average value based on two answers. Notes: Butyl acetate has CAS number 123-86-4.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 166mg / 87,69 mg = 1,893 g/g CM2: 70 mg/64 mg = 1,093 g/g CM3: 170mg /181 mg = 0,939 g/g (CM1+CM2+CM3)/3 = 1,308 g Cu/g This is an average value based on three answers.	Input	Refined resource	Copper	1.308			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 1 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 1e-3/1000/0,0877 = 1,14e-5 g This is not an average value and the figure is based only on one answer. Notes: dichlorosilane has CAS-number 4109-96-0	Input	Refined resource	dichlorosilane	0.00001			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1: 57 000 g / 650 000 pieces --> 0,08777 g / diode 32kWh is consumed for 1000 diodes ---> 32/ 0,0877 Wh / g = 364,88 Wh /g diode Component manufacturer 2: Each diode weighs 64 mg. We had to adjust the materials really used in the product. 7,5 Wh / 0,064 g = 117,16 Wh / g diode (364,88 + 117,16)/2 = 241,022 Wh/g diode This is an average value based on two answers.	Input	Refined resource	Electricity	241.022			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 278 mg / 87,69 mg = 3.17 g/g (Mold compound assumed by Ericsson to be Epoxy plastic) CM2: 32 mg/64 mg = 0.5 g/g CM3: 60 mg /181 mg = 0,33 g/g (CM1+CM2+CM3)/3 = 1.33 g EP/g This is an average value based on three answers.	Input	Refined resource	Epoxy	1.33			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 3 states they use 6 mg for a diode which weighs 0,181 g. Hence, 0,006 / 0,181 = 0,033 g This is not an average value and the figure is based only on one answer. Notes: Ethyl Alcohol has CAS-number 64-17-5	Input	Refined resource	Ethyl Alcohol	0.01657			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 0,039 dm3 for 1000 diodes. One diode weighs 0,0877 grams. According to	Input	Refined resource	H2O2	0.22			g	Technosphere	

	http://www.chemfinder.com /cgi-win/cfserver.exe/ H2O2 has a specific gravity of 1,4067 kg/dm3. Hence, 1,4067 * 0,039 / 0,0877 = 0,625 g H2O2 The answer from component manufacturer 2 states they use 1 mg for a diode which weighs 0,064 g. Hence, 0,001 / 0,064 = 0,0156 g H2O2 The answer from component manufacturer 3 states they use 5 mg for a diode which weighs 0,181 g. Hence, 0,005 / 0,181 = 0,0276 g H2O2 Average value (0,625 + 0,0156 + 0,0276)/3 = 0,222 g H2O2 This is an average value based on three answers.									
	Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 0,082 dm3 for 1000 diodes. One diode weighs 0,0877 grams. According to http://www.chemfinder.com /cgi-win/cfserver.exe/ H2SO4 has a specific gravity of 1,85 kg/dm3. Hence, 1,85 * 0,082 / 0,0877 = 1,729 g H2SO4 The answer from component manufacturer 2 states they use 1 mg for a diode which weighs 0,064 g. Hence, 0,001 / 0,064 = 0,0156 g H2SO4 The answer from component manufacturer 3 states they use 15 mg for a diode which weighs 0,181 g. Hence, 0,015 / 0,181 = 0,0828 g H2SO4 Average value (1,729 + 0,0156 + 0,0828)/3 = 0,609 g H2SO4 This is an average value based on three answers.	Input	Refined resource	H2SO4	0.6			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 0,055 dm3 for 1000 diodes. One diode weighs 0,0877 grams. According to http://www.chemfinder.com /cgi-win/cfserver.exe/ HF (aq) has a specific gravity of 0,993 kg/dm3. Hence, 0,993 * 0,055 / 0,0877 = 0,6227 g HF (aq) This is not an average value and the figure is based only on one answer.	Input	Refined resource	HF	0.62			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 0,018 dm3 for 1000 diodes. One diode weighs 0,0877 grams. According to http://www.chemfinder.com /cgi-win/cfserver.exe/ HNO3 (aq) has a specific gravity of 1,383 kg/dm3. Hence, 1,383 * 0,018 / 0,0877 = 0,284 g HNO3 (aq) This value is based on one answer.	Input	Refined resource	HNO3	0.28			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 0,027 dm3 for 1000 diodes. One diode weighs 0,0877 grams. According to http://www.chemfinder.com /cgi-win/cfserver.exe/ HCl (aq) has a specific gravity of 0,909 kg/dm3. Hence, 0,909 * 0,027	Input	Refined resource	Hydrochloric acid	0.099			g	Technosphere	

/ 0,0877 = 0,279 g HCl (aq) The answer from component manufacturer 2 states they use 0,4 mg for a diode which weighs 0,064 g. Hence, 0,0004 / 0,064 = 6,25e-3 g HCl (aq) The answer from component manufacturer 3 states they use 2 mg for a diode which weighs 0,181 g. Hence, 0,002 / 0,181 = 0,011 g HCl (aq) Average value (0,279 + 6,25e-3 + 0,011)/3 = 0,09875 g HCl (aq) This is an average value based on three answers.									
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 0,09 m3 for 1000 diodes. One diode weighs 0,0877 grams. According to ISBN 91-27-72174-4, page 71 Hydrogen (g) has a specific gravity of 0,090 kg/m3. Hence, 0,09 *0,09 * 1e-3 / 0,0877 = 0,092 g Hydrogen This is not an average value and the figure is based only on one answer.	Input	Refined resource	Hydrogen	0.09			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 3 states they use 10 mg for a diode which weighs 0,181 g. Hence, 0,010 / 0,181 = 0,55 g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Isopropanol	0.55			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 250 mg/64 mg = 3.9 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Kraftliner	3.9			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 12000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 12 * 0,001 / 0,0877 = 0,136 g Methanesulfonic Acid (75-75-2) /g diode This is not an average value and the figure is based only on one answer. Notes: Methanesulfonic Acid has CAS-number 75-75-2	Input	Refined resource	Methanesulfonic Acid	0.14			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 3 states they use 10 mg for a diode which weighs 0,181 g. Hence, 0,010 / 0,181 = 0,55 g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Methanol	0.55			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they use 0,0035 mg for a diode which weighs 0,064 g. Hence, 0,0035e-3 / 0,064 = 5,47e-5 g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Mo	0.000055			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 6,5 m3 for 1000 diodes. One	Input	Refined resource	N2	92.6			g	Technosphere	

diode weighs 0,0877 grams. According to ISBN 91-27-72174-4, page 71 N2 has a specific gravity of 1,25 kg/m3. Hence, 6,5 *1,25 / 0,0877 = 92,64 g N2 This is not an average value and the figure is based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0,45 dm3 natural gas is used 0,45 dm3 /0,064 g diode (manufacturer 2) = 7,03125 dm3/g diode HHV is 39,89 MJ/m3 (ISBN 91-7548-544-3, page 116) ---> 7,03125e-3 * 39,89 = 0,28 MJ This is not an average value and the figure is based only on one answer. Literature: Brohammer, Produkekologi answer from one manufacturer	Input	Refined resource	Natural gas	0.28			MJ	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 40 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 40e-3/1000 / 0,0877 = 4,56e-4 g NH3 The answer from component manufacturer 3 states they use 8 mg for a diode which weighs 0,181 g. Hence, 0,008 / 0,181 = 0,0442 g NH3 Average value (4,56e-4 + 0,0442)/2 = 0,0223 g NH3 This is an average value based on two answers.	Input	Refined resource	NH3	0.0223			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 1000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 1000e-3/1000 / 0,0877 = 0,00114 g NH4Cl This is not an average value and the figure is based only on one answer.	Input	Refined resource	NH4Cl	0.00552			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0,004 mg/64 mg = 0,0000625 g/g CM3: 10 mg /181 mg = 0,055 g/g (CM2+CM3)/2 = 0,0276 g/g This is an average value based on two answers.	Input	Refined resource	Ni	0.0276			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 700 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 700e-3/1000 / 0,0877 =7,98e-3 g Nickel chloride /g diode This is not an average value and the figure is based only on one answer. Notes: Nickel chloride has CAS-number 13931-83-4	Input	Refined resource	Nickel chloride	0.00387			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The data was given by CM1 in dm3. This figure has been transformed to MJ using Energifakta, 1994 figures for Eo1 furnace oil as follows: 1m3=9960kWh. 1kWh=3.6MJ reference :. 1m3=9960*3.6MJ=35856MJ Given data: 0.0068 dm3 Calculations: 0.0068*1e-	Input	Refined resource	Oil	0.244			MJ	Technosphere	

3*35856=0.244 MJ This is not an average value and the figure is based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 0,046 m3 for 1000 diodes. One diode weighs 0,0877 grams. According to ISBN 91-27-72174-4, page 71 O2 has a specific gravity of 1,43 kg/m3. Hence, 0,046 *1,43 / 0,0877 = 0,75 g O2 This is not an average value and the figure is based only on one answer.	Input	Refined resource	Oxygen	0.75			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,05 mg / 87,69 mg = 0,00057 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Pb	0.00057			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 0,002 dm3 SC resist for 1000 diodes. One diode weighs 0,0877 grams. I assume SC resist has a specific gravity of 1,0 kg/dm3. Hence, 1,0 * 0,002 / 0,0877 = 0,0228 g SC resist The answer from component manufacturer 2 states they use 4 mg for a diode which weighs 0,064 g. Hence, 0,004 / 0,064 = 0,0276 g Etch resist Average value (0,0228 + 0,0276)/2 = 0,0252 g Photoresist This is an average value based on two answers.	Input	Refined resource	Photoresist	0.0252			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they use 0,025 mg for a diode which weighs 0,064 g. Hence, 0,025e-3 / 0,064 = 3,9e-4 g PVC This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polyvinyl Chloride	0.00039			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 6 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 6e-3/1000 / 0,0877 = 6,84e-5 g silane Accroding to http://www.chemfinder.com /cgi-win/cfserver.exe/ Silane is another name for Silicon Tetrahydride CAS no. 7803-62-5 This is not an average value and the figure is based only on one answer. Notes: Silicon Tetrahydride has CAS-number 7803-62-5	Input	Refined resource	Silicon Tetrahydride	0.0000684			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 5,004mg / 87,69 mg = 0,057 g/g (Tin concentrate plus tin additive) CM3: 10 mg /181 mg = 0,055 g/g (tin plate solution) (CM1+CM3)/2 = 0,056 g/g This is an average value based on two answers.	Input	Refined resource	Sn	0.056			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 2.5 mg/64 mg = 0,039 g/g This is not an average value and the figure is	Input	Refined resource	Solder	0.039			g	Technosphere	

based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 6mg / 87,69 mg = 0,068 g/g CM3: 1,5 mg /181 mg = 0,0083 g/g (CM1+CM3)/2 = 0,038 g/g This is an average value based on two answers.	Input	Refined resource	Solder cream	0.038			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they use 0,002 mg for a diode which weighs 0,064 g. Hence, 0,002e-3 / 0,064 = 3,13e-5 g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Ti	1.449E-05			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 1000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 1000e-3/1000 / 0,0877 = 0,011 g trisodium citrate This is not an average value and the figure is based only on one answer. Notes: Trisodium Citrate has CAS-number 68-04-2.	Input	Refined resource	Trisodium Citrate	0.011			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a use of 26000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 26000e-3/1000 / 0,0877 = 0,296 Xylene /g diode This is not an average value and the figure is based only on one answer.	Input	Refined resource	Xylene	0.296			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 94 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 94e-3/1000/ 0,0877 = 0,00107 g acetic acid This is not an average value and the figure is based only on one answer.	Output	Emission	Acetic Acid	0.00107			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they emit 4,7 mg acetone for a diode which weighs 0,064 g. Hence, 0,0047 / 0,064 = 0,073 g This is not an average value and the figure is based only on one answer.	Output	Emission	Acetone	0.073			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 7000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 7000e-3/1000 / 0,0877 = 0,0798 g BOD5 The answer from component manufacturer 2 states they emit 0,16 mg for a diode which weighs 0,064 g. Hence, 0,16e-3 / 0,064 = 0,0025 g BOD5 Average value (0,0798 + 0,0025)/2 = 0,04 g BOD5 This is an average value based on two answers.	Output	Emission	BOD	0.04			g	Water	

Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they emit 4,1 mg for a diode which weighs 0,064 g. Hence, 0,0041 / 0,064 = 0,064 g This is not an average value and the figure is based only on one answer.	Output	Emission	Butyl acetate	0.064			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they emit 0,25 mg for a diode which weighs 0,064 g. Hence, 0,25e-3 / 0,064 = 3,9e-3 g This is not an average value and the figure is based only on one answer.	Output	Emission	Cl-	0.0039			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 3700 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 3700e-3/1000/ 0,0877 = 0,042 g CO This is not an average value and the figure is based only on one answer. Notes: CO = Carbon monoxide	Output	Emission	CO	0.042			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 30000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 30000e-3/1000 / 0,0877 = 0,342 g COD5 The answer from component manufacturer 2 states they emit 0,25 mg for a diode which weighs 0,064 g. Hence, 0,25e-3 / 0,064 = 0,0039 g COD5 Average value (0,342 + 0,0039)/2 = 0,173 g COD5 This is an average value based on two answers.	Output	Emission	COD	0.00362			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 2000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 2000e-3/1000 / 0,0877 = 0,023 g F- The answer from component manufacturer 2 states they emit 0,009 mg for a diode which weighs 0,064 g. Hence, 0,009e-3 / 0,064 = 1,4e-4 g F- Average value (0,023 g + 1,4e-4 g)/2 = 0,0116 g F- This is an average value based on two answers.	Output	Emission	F-	0.012			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 2000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 2000e-3/1000/ 0,0877 = 0,022 g F- This is not an average value and the figure is based only on one answer.	Output	Emission	F-	0.022			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they emit 4,9 mg for a diode which weighs 0,064 g.	Output	Emission	HC	0.076			g	Air	

Hence, 4,9e-3 / 0,064 = 0,076 g This is not an average value and the figure is based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they emit 0,95 mg for a diode which weighs 0,064 g. Hence, 0,95e-3 / 0,064 = 0,0148 g This is not an average value and the figure is based only on one answer.	Output	Emission	HF	0.0148			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 170 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 170e-3/1000 / 0,0877 = 1,938e-3 g HNO3 The answer from component manufacturer 2 states they use 0,95 mg for a diode which weighs 0,064 g. Hence, 0,95e-3 / 0,064 = 0,0148 g HNO3 Average value (1,938e-3 + 0,0148)/2 = 8,369e-3 g HNO3 This is an average value based on two answers.	Output	Emission	HNO3	0.00837			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 1000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 1000e-3/1000/ 0,0877 = 0,011 g NH3 This is not an average value and the figure is based only on one answer.	Output	Emission	NH3	0.011			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 6400 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 6400e-3/1000/ 0,0877 = 0,073 g NO2 This is not an average value and the figure is based only on one answer.	Output	Emission	NO2	0.073			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 6000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 6000e-3/1000 / 0,0877 = 0,064 g NO2- This is not an average value and the figure is based only on one answer.	Output	Emission	NO2-	0.064			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 280 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 280e-3/1000 / 0,0877 = 0,00319 g PO43- This is not an average value and the figure is based only on one answer.	Output	Emission	PO43-	0.003			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they emit 0,0032 mg for a diode which weighs 0,064 g. Hence, 0,0032e-3 / 0,064 =	Output	Emission	Sn	0.00005			g	Water	

5e-5 g tin This is not an average value and the figure is based only on one answer.								
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 2200 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 2200e-3/1000/ 0,0877 = 0,025 g SO2 This is not an average value and the figure is based only on one answer.	Output	Emission	SO2	0.025			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they emit 0,8 mg for a diode which weighs 0,064 g. Hence, 0,8e-3 / 0,064 = 0,0125 g SO42- This is not an average value and the figure is based only on one answer.	Output	Emission	SO42-	0.0125			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states an emission of 10000 mg for 1000 diodes. One diode weighs 0,0877 grams. Hence, 10000e-3/1000 / 0,0877 = 0,114 g suspended solids	Output	Emission	Suspended solids	0.11			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they emit 0,13 mg for a diode which weighs 0,064 g. Hence, 0,13e-3 / 0,064 = 0,002 g Trichloroethylene This is not an average value and the figure is based only on one answer.	Output	Emission	Trichloroethylene	0.002			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they emit 1,8 mg for a diode which weighs 0,064 g. Hence, 1,8e-3 / 0,064 = 0,028 g trimethyl benzene This is not an average value and the figure is based only on one answer. Notes: Trimethyl Benzene has CAS-number 25551-13-7	Output	Emission	Trimethyl Benzene	0.028			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 states they use 6,5 mg for a diode which weighs 0,064 g. Hence, 6,5e-3 / 0,064 = 0,101 g Xylene This is not an average value and the figure is based only on one answer.	Output	Emission	Xylene	0.101			g	Air	
Date concieved: 1999 Data type: Derived, unspecified Method: 1 gram diode output is the base for all figures in this model.	Output	Product	Diodes	1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: I assume all butyl acetate used in the process is wasted but recycled according to manufacturer 1. This is not an average value and the figure is based only on one answer.	Output	Residue	Butyl acetate	0.06			g	Technosphere	

Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 state 1,14 mg waste of mud is generated for a diode which weighs 0,064 g. Hence, 1,14e-3 / 0,064 = 0,0178 g mud This is not an average value and the figure is based only on one answer.	Output	Residue	Mud	0.018			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: I assume all photo resist used in the process is wasted but recycled according to manufacturer 1. This is not an average value and the figure is based only on one answer.	Output	Residue	Photoresist	0.0252			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 state 0,6 mg waste of solvents is generated for a diode which weighs 0,064 g. Hence, 0,6e-3 / 0,064 = 9,375e-3 g solvents This is not an average value and the figure is based only on one answer.	Output	Residue	Solvent	0.009375			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The answer from component manufacturer 2 state 0,05 mg waste of chlorinated solvents is generated for a diode which weighs 0,064 g. Hence, 0,05e-3 / 0,064 = 7,81e-4 g solvents This is not an average value and the figure is based only on one answer.	Output	Residue	Solvents, chlorinated	0.000781			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Component manufacturer 1 states a waste amount of 0,026 dm3 for 1000 diodes. One diode weighs 0,0877 grams. According to http://www.chemfinder.com /cgi-win/cfserver.exe/ the specific gravityof xylene is 0,862 kg/dm3. Hence, 0,026 * 0,867 / 0,0877 = 0,257 g xylene /g diode This is not an average value and the figure is based only on one answer.	Output	Residue	Xylene	0.257			g	Technosphere	

About Inventory	
Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB.

	Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a diode manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the silicon wafer production and final assembly of diodes and resembling components in our telecom products. The usage for this set of data are life cycle assessments where diodes are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to diodes in electronic equipment if you know how much the diode weight. Here follows a more detailed description of transports of materials and components to the

respective manufacturer factories. These transports are not included in the model.

CM1 = Component manufacturer one

The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport.

-- Truck transportation: --

Component manufacturer one (CM1):

Weight of component: 0.08777 g

Leadframe with weight 0.166 g is transported 400 km by road i.e. 0.166 g*400 km, Mold compound 0.278 g*200 km and Solder paste 0.0056 g*200.

The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives:

123.12 gkm/0.08777 = 1402.75 gkm/g diode

Component manufacturer two (CM2):

Weight of component: 0.064 g

Silicon with weight 0.0025 g is transported 900 km by road i.e. 0.0025 g*900 km,

This gives:

2.25 gkm/0.064 = 35.16 gkm/g diode

Component manufacturer three (CM3):

Weight of component: 0.181g

Copper leadframe with weight 0.06 g is transported 120 km by road i.e. 0.06 g*120 km, Epoxy resin 0.06 g*120 km, Copper jumper 0.03 g * 2000 km, Silicon die 0.03 g ' 120 km and Solder paste 0.0015 g*2000 km.

The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives:

81 gkm/0.181 g = 447.51 gkm/g diode

This gives the average total transportation work by truck for CM1 and CM2:
(CM1+CM2+CM3)/3 = 628.47 gkm/g

-- Airplane transportation: --

The answer from component manufacturer 3 states they transport 30 mg of Silicon die 2000 km by air for a diode which weighs 0,181 g.

Hence,
30e-3 / 0,181 * 2000 = 331,41 gkm/g diode

-- Boat transportation: --

Component manufacturer one (CM1):

Weight of component: 0.08777 g

Leadframe with weight 0.166 g is transported 100 km by boat i.e. 0.166 g*100 km, Mold compound 0.278 g*12000 km and Solder paste 0.056 g*700.

The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives:

3356.52 gkm/ 0.08777 g = 38242.22 gkm/g

Component manufacturer one (CM3):

Weight of component: 0.181 g

Epoxy resin with weight 0.06 g is transported 2000 km by boat i.e. 0.06 g*2000 km,

120 gkm/ 0.181 g = 662.98 gkm/g

Average:

	(CM1+CM3)/2 = 19452,6 gkm/g diode
About Data	The data is based on information from one Irish, one Italian and one British manufacturer. The information was gathered using a life cycle inventory questionnaire. All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model. Of the flows about little more than 76 % are not average values.The flows for Raw material input of Butyl acetate, Copper, Epoxy resin, H2O2, H2SO4, HCl, NH3, Ni, Photoresist, Sn, Solder cream, emission to Air of HNO3, emission to water of BOD, COD, F- and Energy ware input of Electricity are average values. In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included. The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. The result is that approximately 12 % of the flows used in all manufacturers answers were only calculated, 45 % were only estimated, 41 % were only measured and 2 % were first estimated and then calculated. The outline of the LCI data questionnaire that were used in the inventory follows below. No limitations or specifications were set for which substances they had to account -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes.´ Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gatherd it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Dismounting of bearing

Administrative	
Finished	Y
Date Completed	2002-12-18
Copyright	
Availability	Public

Technical System	
Name	Dismounting of bearing
Functional Unit	1.2 ton bearing
Functional Unit Explanation	One SKF spherical roller bearing 232/530 weighs 1.2 ton.
Process Type	Unit operation
Site	Stora Enso Hylte ABHylte Mill S- 314 81 HYLTEBRUK Sweden
Sector	Construction
Owner	Stora Enso Hylte ABHylte Mill S- 314 81 HYLTEBRUK Sweden
Technical system description	This activity describes the dismounting of bearing. The roller bearing is dismounted from the soft calender roll of a paper machine at Storaenso AB in Hyltebruk using a manual hydraulic pump and a small amount of lubricant.

System Boundaries	
Nature Boundary	Nor the bearings or the lubricant enters from or leaves to the nature.
Time Boundary	Data is collected autumn 2002. No changes are planned for the nearest future.
Geographical Boundary	This dismounting procedure is performed at Storaenso, Hyltebruk, Sweden.
Other Boundaries	
Allocations	Because of that the dismounting takes place two times during the bearings lifetime, the double amount of mounting fluid each time is used. The density of the mounting fluid is 0.894 kg/l.
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	2002-09-01- 2002-12-31
Data Type	Unspecified, expert outspoke
Represents	N/A
Method	The data is gathered interviewing Dan Hedin on a visit at Stora Enso Hylte AB.
Literature Reference	N/A
Notes	N/A

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: SKF, SRB 232/530	Input	Refine resource	Bearing	1.2			tonne	Technosphere	Sweden
Notes: Mounting fluid used to facilitate the dismounting.	Input	Refine resource	SKF LHMF 300	0.1788			kg	Technosphere	Sweden
Notes: SKF, SRB 232/530	Output	Residue	Bearing	1.2			tonne	Technosphere	Sweden

Notes: A certain amount of the lubricant is left inside the bearing after the circulation of lubricant has stopped.	Output	Residue	Mobil DTE PM 220	0.3568			kg	Technosphere	Sweden
Notes: Mounting fluid used to facilitate the dismounting.	Output	Residue	SKF LHMF 300	0.1788			kg	Technosphere	Sweden

About Inventory	
Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002. -------------- Data documented by sandra Häggström, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-03-21.
Intended User	Product developer at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The purpose for our study is to compare a coated roller bearing to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases, and lubricated with circulating oil.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	Presumably on all bearings being dismounted from a soft calender in a paper machine.
About Data	Data is collected by inteviewing Dan Hedin and Bernt Petersson at Storaenso, Hyltebruk.
Notes	

SPINE LCI dataset: Disposal of polyethylene to landfill.

Administrative	
Finished	Y
Date Completed	2003-01-10
Copyright	
Availability	Public

Technical System	
Name	Disposal of polyethylene to landfill.
Functional Unit	1000 kg of polyethylene
Functional Unit Explanation	Disposal of a tonne of polyethylene waste in accordance with the legal requirements was used as a functional unit.
Process Type	Gate to grave
Site	Europe
Sector	Waste management
Owner	Europe
Technical system description	The present analysis of waste treatment is based on the study ''Life cycle inventories of disposal processes - Basics for integration of the disposal in life cycle assessments'' (ESU-ETHZ 1996). This activity describes the disposal of 100% polyethylene wastes to the landfill. Polyethylene(PE) wastes are collected, transported and deposited directly to the reactor

	landfill. These data represent the situation in Switzerland in year 1995. The results are shown as an overall reactor landfill process including landfill gas recovery, waste water treatment of the leaching water and sewage treatment. Waste collection and transportation are also included into the study. The material content of the Polyethylene(PE) results from the chemical structural formula and the literature, and as follows: C (fossil)=841 kg/t PE H = 141 kg/t PE N = 0,7 kg/t PE Cl = 1,7 kg/t PE S = 0,5 kg/t PE Ash = 12 kg/t PE Density = 0,92-0,95 t/m3 Water content = 3,6 kg/t PE Upper heating value = 45,8 GJ/t Lower heating value = 39 GJ/t (PE should be regarded as PE/PP (Polypropylene) with a low water content) Waste collection and transportation An average distance of 10 km/t waste was assumed. The diesel consumption is 4 l/t waste. The transportation is carried out by truck. Reactor landfill The monitored phase lasts 150 years (processes included: chemical processes, leaching water formation, leaching water treatment, gas use). The degradability of the plastic in the monitored phase was estimated to be 5%. Before deposition, the amount of waste is weighed and recorded. The wastes are then distributed and compacted at the reactor landfill using compactors. Both leaching water and landfill gas are collected by means of leaching water lines. Leaching water is fed to a processing installation for treatment. Treatment of sewage sludge is also taken into account. On completion of the methane phase, the landfill material is allowed to settle for a period of time. Then the landfill surface is sealed with clay and earth, and recultivated. In the study it is assumed that the landfill cover is permiable. The energy expenditure in the operation consists of waste addition and compaction using construction machinery, the construction of the drainage system, and the operation of the landfill gas pumps and buildings. (SAEFL) Literature reference: Life Cycle Inventories for Packagings. Swiss Agency for the Environment, Forests and Landscape (SAEFL). Environmental Series No. 250/I-II. Waste. 1998. [ESU-ETHZ, 1996] - Doka G., Huber F., Labhardt A., Menard M., Zimmermann P.; ''Ökoinventare von Entsorgungsprozessen - Grundlagen zur Intergation der Entsorgung in Ökobilanzen'', ESU series 1/96; Institute fur Energietechnik, Gruppe Energie-Stoffe-Umwelt, ETH Zurich, 1996. For more literature references see: ''About data''.

System Boundaries

Nature Boundary	In the reactor landfill process, the landfill gas incineration is integrated in the system boundaries and considered as a disposal process to ensure legal requirements. The results are shown as an overall reactor landfill process including landfill gas recovery, waste water treatment of the leaching water and sewage treatment. Waste collection and transportation are also included into the study. All emissions (to air, water, ground) are included.
Time Boundary	Data represent situation in Switzerland in year 1995. The data were updated in 1998. The data were collected in the period from 1993 to 1995, except for energy and transport values; these apply to the situation of 1990.
Geographical Boundary	Primarily, areas relevant to the economic region of Switzerland were investigated. Where possible and meaningful, the economic region was expanded. In such cases, the process data are based on import statistics that involves production countries important to Switzerland.
Other Boundaries	Energy production is regarded as a by-product and is free from emissions. The energy produced in the reactor landfill is reconciled directly with the energy consumption of the reactor landfill. This procedure is based on the assumption that the energy produced is needed simultaneously in the same plant.
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData	
Date Conceived	20021010/20030110
Data Type	Derived, mixed
Represents	N/A
Method	100% of plastic wastes (PE) are deposited according to the current status of disposal technology. Switzerland, 1995. See reference.
Literature Reference	Life Cycle Inventories for Packagings. Swiss Agency for the Environment, Forests and Landscape (SAEFL). Environmental Series No. 250/I-II. Waste. 1998.
Notes	N/A

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Raw brown coal	Input	Natural resource	Brown coal	0.0684			kg	Ground	
	Input	Natural resource	Crude oil	4.24			kg	Ground	
Notes: Raw hard coal	Input	Natural resource	Hard coal	0.0653			kg	Ground	
	Input	Natural resource	Hydro energy	2.08			MJ	Ground	
	Input	Natural resource	Natural gas	4			MJ	Ground	
	Input	Natural resource	Uranium in ore	0.0179			g	Ground	
	Input	Natural resource	Water	0.00105			m3	Ground	
	Input	Natural resource	Wood	0.000638			kg	Ground	
	Input	Refined resource	Diesel	198			MJ	Technosphere	
	Input	Refined resource	Electricity	10			MJ	Technosphere	
Notes: Useful heat from industrial firing EL (CH), primary energy source: crude oil.	Input	Refined resource	Heating oil	6			MJ	Technosphere	
	Input	Refined resource	Plastic waste	1000			kg	Technosphere	
	Output	Emission	Al	0.111			g	Water	
	Output	Emission	Aromatic HC	0.181			g	Water	
	Output	Emission	As	0.000381			g	Water	
	Output	Emission	Ba	0.54			g	Water	
	Output	Emission	Benzene	0.0529			g	Air	
	Output	Emission	BOD	0.019			g	Water	
	Output	Emission	C	172			g	Ground	
	Output	Emission	Cd	0.000225			g	Air	
	Output	Emission	Cd	0.000751			g	Ground	
	Output	Emission	Cd	0.065			g	Water	
	Output	Emission	Cl-	123			g	Water	
	Output	Emission	CN-	0.000831			g	Water	
	Output	Emission	CO	82.7			g	Air	
	Output	Emission	CO2	128000			g	Air	
	Output	Emission	COD	0.619			g	Water	
	Output	Emission	Cr	0.00287			g	Water	
	Output	Emission	Cu	0.436			g	Water	
	Output	Emission	Dissolved organics	0.00163			g	Water	
	Output	Emission	Dust	14			g	Air	
	Output	Emission	Fe	0.174			g	Water	
	Output	Emission	Halon	0.00101			g	Air	
	Output	Emission	HC	0.0884			g	Air	
	Output	Emission	HCl	0.0547			g	Air	
	Output	Emission	HF	0.00943			g	Air	
	Output	Emission	Hg	0.0063			g	Ground	
	Output	Emission	Hg	0.163			g	Air	
	Output	Emission	Hg	0.579			g	Water	

	Output	Emission	Inorganic salts and acids	82.8			g	Water	
	Output	Emission	Metals	0.0523			g	Air	
	Output	Emission	Metals	1.31			g	Water	
	Output	Emission	Methane CH4	14500			g	Air	
	Output	Emission	Mn	0.000217			g	Air	
	Output	Emission	N total	0.451			g	Water	
	Output	Emission	N total	1.35			g	Ground	
	Output	Emission	N2O	0.393			kg	Air	
	Output	Emission	NH3	0.225			g	Air	
	Output	Emission	NH4+	17.7			g	Water	
	Output	Emission	Ni	0.00113			g	Water	
	Output	Emission	Ni	0.00684			g	Air	
	Output	Emission	NO3-	2800			g	Water	
	Output	Emission	Non-methane HC	89.7			g	Air	
	Output	Emission	NOx	198			g	Air	
	Output	Emission	Oil	5.65			g	Water	
	Output	Emission	PAH	0.000144			g	Air	
	Output	Emission	PAH	0.00277			g	Water	
	Output	Emission	Pb	0.0000209			g	Ground	
	Output	Emission	Pb	0.00101			g	Air	
	Output	Emission	Pb	0.00204			g	Water	
	Output	Emission	Phenol	0.0281			g	Water	
	Output	Emission	PO4---	0.00851			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive isotopes	14.4			kBq	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive isotopes	1560			kBq	Air	
	Output	Emission	S--	0.00663			g	Water	
	Output	Emission	SO2	39.5			g	Air	
	Output	Emission	SO4--	1470			g	Water	
	Output	Emission	Suspended solids	12.2			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	TCDD equivalents	25.9			ng	Air	
	Output	Emission	Toluene	0.0252			g	Water	
	Output	Emission	Total organic carbon	807000			g	Water	
	Output	Emission	Zn	0.163			g	Air	
	Output	Emission	Zn	0.671			g	Water	
	Output	Emission	Zn	7.33E-07			g	Ground	

About Inventory

Publication	Life Cycle Inventories for Packagings. Swiss Agency for the Environment, Forests and Landscape (SAEFL). Environmental Series No. 250/I-II. Waste. 1998. -- Data documnented by: Anastassia Manuilova. Chalmers University of Technology and Akzo Nobel Surface Chemistry AB. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-05-28
Intended User	LCA practitioners in industry,
General Purpose	To analyse the treatment and disposal processes of used packaging
Detailed Purpose	To calculate the environmental loads from treatment and disposal of plastic packaging. The data were used in the Master of Science thesis work ''Life Cycle Assessment of Industrial Packaging for Chemicals''. Anastassia Manuilova. Chalmers University of Technology and Akzo Nobel Surface Chemistry AB. 2003. The overall aim of the study was to evaluate the potential environmental effect of steel and plastic packaging used at Akzo Nobel site Stenungsund over the entire life cycle with emphasis on reuse and recycling.
Commissioner	- Akzo Nobel Surface Chemistry AB 444 85 Stenungsund Sweden.

Practitioner	Manuilova, Anastassia - Akzo Nobel Surface Chemistry Environmental Development S-444 85 Stenungsund Sweden.
Reviewer	
Applicability	As Switzerland is considered the assessment area, the results of the cumulated environmental burdens can be applied only to this country.
About Data	The data were derived from the following sources: Energy systems: [ESU-ETHZ, 1994] Waste treatment processes: [ESU-ETHZ, 1996] The data on collection and transportation of waste are derived from literature.[SAEFL, 1995], [ESU-ETHZ, 1994] The references mentioned above: [ESU-ETHZ, 1996] - Doka G., Huber F., Labhardt A., Menard M., Zimmermann P.; ''Ökoinventare von Entsorgungsprozessen - Grundlagen zur Intergation der Entsorgung in Ökobilanzen'', ESU series 1/96; Institute fur Energietechnik, Gruppe Energie-Stoffe-Umwelt, ETH Zurich, 1996. [SAEFL, 1995]- Luftschadstoff-Emissioner des Strassenverkehrs 1950-2010, Bundesamt fur Umwelt, Wald und Landschaft (publisher), Schriftenreihe Umwelt No.255, S.185/193, Bern 1995. [ESU-ETHZ, 1994] - Frischknecht R., Hofstetter P., Knoepfel I., Dones R., Zollinger E. et al.; Ökoinventare fur Energiesysteme, ESU-Reihe 1/94; Laboratorium fur Energiesysteme, Gruppe Energie-Stoffe-Umwelt, ETH Zurich/PSI Villigen, 1994.
Notes	The data were used in the Master of Science thesis work ''Life Cycle Assessment of Industrial Packaging for Chemicals''. Anastassia Manuilova. Chalmers University of Technology and Akzo Nobel Surface Chemistry AB. 2003.

SPINE LCI dataset: Dry wood chips fired plant for heat and power production - Large plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Dry wood chips fired plant for heat and power production - Large plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a wood chips fired plant for heat and power production. The plant is located in Sweden and is fired with dried wood chips and wood briquettes when the drier is shutdown. The heat is delivered to a district heating net. Production of materials, chemicals and electricity and transport, used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): 5251/4865 Total electric power output (MW): 30 Total thermal output (MW): 128 Annual total fuel use (MWh): 529 884

	Normal annual production of heat (MWh): 354 555 Normal annual production of electricity (MWh): 99 026 Degree of thermal efficiency (%): 85,6 PROCESS DESCRIPTION: The plant consists of two steam boiler units of about 80 MW thermal and electric power output each. The wood chips are dried in a steamdryer before combustion. When the dryer is shutdown, wood briquettes are used as fuel. The dust is removed from the flue gas in an electrostatic precipitator. INCLUDED OPERATIONS: The process of the study consists of the following operations: - The feeding of the dry wood chips wood into the combustion process. - The combustion process. - The removal of dust from the flue gas in the electrostatic precipitator. - The internal treatment of the residues from the combustion process. - The internal consumption of electricity. - The internal consumption of chemicals used in the flue gas system and in the feed water treatment. - The NOx control system. NOx CONTROL: Both boilers are equiped with SNCR systems with urea as the reduction agent and flue gas recirculation. - SNCR (Selective Noncatalytic Reduction) describes a method for reducing the NOx already formed during the combustion process. In the process, an aqueous reduction agent mixed in water or steam is injected into the furnace during the combustion process. The reduction agent reduces the NOx and forms nitrogen and water. - Flue gas recirculation describes a method for limiting the NOx-formation during the combustion process. The process involves temperature and air supply optimization during the combustion process. Combustion at low temperature and with a low air factor reduces the NOx level. OTHER FLUE GAS CLEANING SYSTEMS: - For the removal of dust from the flue gas an electrostatic precipitator is used. In an electrostatic precipitator the dust particles are electrified and then separated from the flue gas stream by passing through an electric field with largest possible intensity. - Due to the low sulphur content in wood fules, no reduction of the sulphur content in the flue gas is needed.

System Boundaries	
Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. The emission of HC is not measured.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION This inventory has been conducted on a dry wood chips fired plant for heat and power production in Sweden, with swedish regulations, applicable during 1996. The collected data should only be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the internal electricity consumption. - The production of the dried wood chips fuel. - The transportation of the fuel to the plant. - The transportation of the residues from the combustion and cleaning processes to the landfill or back to the forest. - The processes at the landfill such as leaching, decomposition etc. - The spreading of the ashes in the forest. EXCLUDED FLOWS - The chemicals used for feed water treatment. - The water consumption in the process.
Allocations	PRINCIPLE APPLIED: In a combined power and heating plant two products of economic value are produced. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat and power respectively. For the use of resources and the emissions that are specific for the electric power production are allocated to that production. Equivalent to this the use of resources and the emissions specific for the heat production are allocated to that production. Note: When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.

	DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	N/A
Method	All data reported are related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amount of an input (fuel, chemical, electricity etc.) to or an output (emission, product etc.) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the total yearly amount with the yearly amount of produced heat and multiplying with the fraction of the total production that are associated with the heat production. For some flows specific information is given, see each flow.
Literature Reference	Data are in general recieved from ''Miljörapport 1996, Borås Energi AB''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: Every transport of wood chips is weighed at the plant and reported in the Environmental Report. Literature: Miljörapport 1996, Borås Energi AB	Input	Refined resource	Bio fuel	472			g	Technosphere	
Method: Not known.	Input	Refined resource	Electricity	0.0509			kWh	Technosphere	
Data type: Monitored data, continuous Method: This emission is measured continuously. Literature: Miljörapport 1996, Borås Enrgi AB	Output	Emission	CO	0.374			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with biofuels, according to NUTEK. The standard value for biofuels is 114 g/MJ fuel supplied	Output	Emission	CO2	479			g	Air	
Data type: Single sample Method: This emission is mesured at the yearly periodical inspection. The yearly amount of the emission is then estimated from this single sample. Literature: Miljörapport 1996, Borås Energi AB	Output	Emission	Dust	0.00417			g	Air	
Data type: Monitored data, continuous Method: This emissionn is measured continuously. Literature: Miljörapport 1996, Borås Energi AB	Output	Emission	NOx	0.253			g	Air	
Data type: Monitored data, continuous Method: This emission is measured contiuously. Literature: Miljörapport 1996, Borås Energi AB	Output	Emission	SO2	0.00847			g	Air	
Method: Not known. Literature: Miljörapport 1996, Borås Energi AB	Output	Product	Heat	1			kWh	Technosphere	
Method: Every transport with bottomash is weight before it leaves the plant. Literature: Miljörapport 1996, Borås Energi AB	Output	Residue	Bottom ash	0.013			g	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden. This data should only be used on plants producing heat in Sweden and for swedish conditions. When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.
Notes	Combined heat and power are used as base primarily during the winter half, when the need for heat and power are the largest.

SPINE LCI dataset: ED95 - Sugar cane, cradle-to-gate, energy allocation, impact categories only - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	ED95 - Sugar cane, cradle-to-gate, energy allocation, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of ED95 fuel
Process Type	Cradle to gate
Site	

Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of ED95 based on ethanol from sugar cane. The following processes are covered: - Cultivation of the sugar cane - Harvest - Distribution to the fuel plant - Production of ethanol - Transportation of ethanol from Brazil to a Swedish port Indirect land use change is considered not to occur, as there are no confirmed links under current situation (Berndes et al, 2010 in Börjesson et al 2010). Data in Börjesson et al. are only published as impact categories and not as emissions except for particles. The amount of primary energy is not mentioned either. A case with allocation is made in Börjesson et al. In the f3 fuels data project, data sets both with and without system expansion are published. ED95 is an ethanol based fuel used in diesel engines (trucks and buses). In Sweden ED95 is produced by SEKAB, Domsjö, Örnsköldsvik. The ethanol for ED95 can be produced from different raw materials such as wheat, sugar beet, sugar cane etc., but since last year (2012) SEKAB only purchases ethanol from Brazilian sugar canes, since it is considered to be the most sustainable . The composition of ED95 is 94 w-% denaturised hydrous ethanol and 6 w-% components. The components function are ignition improver, lubricant and denaturant. SEKAB (1) has provided the exact composition and chemical information about the components as well all relevant physical properties such as densities, heat values and fossil carbon contents. These data are however confidential. Two LCA models of the ED95 fuel was made; based on Brazilian sugar cane ethanol and based on ethanol from wheat. The models include the upstream production of the raw materials, but not the ED95 production itself. Since the composition is confidential, only the LCI-results from this model were published in the database. For the production of ethanol (cradle to gate) data from Börjesson 2010 (2) were used for both sugar cane and wheat ethanol. For each ethanol, a scenario with energy alloaction and system expansion are published. The ignition improver and lubricant are produced by AkzoNobel Surface Chemistry (3). They have LCA data for their production, but could not provide the data within the timeframes of the project. Instead data were found in a Master thesis performed for AkzoNobel Surface Chemistry (4). These data are from 2003 and were the most recent data available. Data for the denaturant were found in the EcoInvent database (5). The data were recalculated from per kg to per MJ of fuel by using a heat value of 25.7 MJ/kg (1). The following processes are covered: - Cultivation of the sugar cane - Harvest - Distribution to the fuel plant - Production of ethanol - Transportation of ethanol from Brazil to a Swedish port Indirect land use change is considered not to occur, as there are no confirmed links under current situation (Berndes et al, 2010 in Börjesson et al 2010). Data in Börjesson et al. are only published as impact categories and not as emissions except for particles. The amount of primary energy is not mentioned either. A case with allocation is made in Börjesson et al. In the f3 fuels data project, data sets both with and without system expansion are published.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Brazil and Europe
Other Boundaries	
Allocations	Energy allocation between ethanol and excess electricity from the production step.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	N/A
Method	Literature studies of Brazilian ethanol production. General data. For additives site specific data as well as database data have been used.
Literature Reference	(1) SEKAB, Roger Mattebo, personal communication 2013. (2) Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH. (3) AkzoNobel Surface Chemistry, Johanna Martinsson, personal communication 2013. (4) LIFE CYCLE ASSESSMENT OF WOOD-BASED ETHANOL-DIESEL BLENDS (E-DIESEL) MASTER OF SCIENCE THESIS, JOSÉ CANGA RODRÍGUEZ, INTERNATIONAL MSC IN EVIRONMENTALLY SUSTAINABLE PROCESS TECHNOLOGY, CHALMERS UNIVERSITY OF TECHNOLOGY, 2003. (5) EcoInvent database: published by Swiss Center of Life Cycle Inventories (www.ecoinvent.org).
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Only from production of additives	Input	Resource	Crude oil	9.08985314564428E-02			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Hard coal	2.15446501517639E-03			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Lignite	2.73334547413471E-04			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Natural gas	7.65109484411067E-02			MJ	Ground	
Notes: Not mentioned in the reference for ethanol production (ref 1)	Input	Resource	Primary energy	0			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Renewable energy resources	3.82466111291545E-03			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Uranium	9.43947214564627E-03			MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. From production of additives as well as ethanol	Output	Emission	Acidification (AP)	2.77505548253344E-04			kg	Air	
Notes: Given as kg PO4-eq combined emissions. From production of additives as well as ethanol	Output	Emission	Eutrophication (EP)	6.14151143612391E-05			kg	Air	
Notes: Given as kg CO2-eq combined emissions. From production of additives as well as ethanol.	Output	Emission	Global warming (GWP)	2.28587649615041E-02			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Particles (unspecified)	1.03124881616875E-05			kg	Air	
Notes: Given as kg ethene-eq combined emissions. From production of additives as well as ethanol	Output	Emission	Photo-oxidant formation (POCP)	3.71819829077694E-05			kg	Air	
	Output	Product	ED95 from sugar cane	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner

General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Hallberg, IVL.
Reviewer	-
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	The data for the ethanol is published in the data set "Ethanol from sugar cane, cradle-to-gate, energy allocation - f3 fuels".

SPINE LCI dataset: ED95 - Sugar cane, cradle-to-gate, system expansion, impact categories only - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	ED95 - Sugar cane, cradle-to-gate, system expansion, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of ED95 fuel from sugar cane
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of ED95 based on ethanol from sugar cane. ED95 is an ethanol based fuel used in diesel engines (trucks and buses). In Sweden ED95 is produced by SEKAB, Domsjö, Örnsköldsvik. The ethanol for ED95 can be produced from different raw materials such as wheat, sugar beet, sugar cane etc., but since last year (2012) SEKAB only purchases ethanol from Brazilian sugar canes, since it is considered to be the most sustainable . The composition of ED95 is 94 w-% denaturised hydrous ethanol and 6 w-% components. The components function are ignition improver, lubricant and denaturant. SEKAB (1) has provided the exact composition and chemical information about the components as well all relevant physical properties such as densities, heat values and fossil carbon contents. These data are however confidential. Two LCA models of the ED95 fuel was made; based on Brazilian sugar cane ethanol and based on ethanol from wheat. The models include the upstream production of the raw materials, but not the ED95 production itself. Since the composition is confidential, only the LCI-results from this model were published in the database. For the production of ethanol (cradle to gate) data from Börjesson 2010 (2) were used for both sugar cane and wheat ethanol. For each ethanol, a scenario with energy alloaction and system expansion are published. The ignition improver and lubricant are produced by AkzoNobel Surface Chemistry (3). They have LCA data for their production, but could not provide the data within the timeframes of the project. Instead data were found in a Master thesis performed for AkzoNobel Surface

	Chemistry (4). These data are from 2003 and were the most recent data available. Data for the denaturant were found in the EcoInvent database (5). The data were recalculated from per kg to per MJ of fuel by using a heat value of 25.7 MJ/kg (1). he following processes are covered: - Cultivation of the sugar cane - Harvest - Distribution to the fuel plant - Production of ethanol - Transportation of ethanol from Brazil to a Swedish port Indirect land use change is considered not to occur, as there are no confirmed links under current situation (Berndes et al, 2010 in Börjesson et al 2010). Data in Börjesson et al. are only published as impact categories and not as emissions except for particles. The amount of primary energy is not mentioned either. A case with allocation is made in Börjesson et al. In the f3 fuels data project, data sets both with and without system expansion are published.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Brazil and Europe
Other Boundaries	
Allocations	No.
Systems Expansions	Excess electricity is replacing electricity based on natural gas.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	N/A
Method	Literature studies of Brazilian ethanol production. General data. For additives site specific data as well as database data have been used.
Literature Reference	(1) SEKAB, Roger Mattebo, personal communication 2013. (2) Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH. (3) AkzoNobel Surface Chemistry, Johanna Martinsson, personal communication 2013. (4) LIFE CYCLE ASSESSMENT OF WOOD-BASED ETHANOL-DIESEL BLENDS (E-DIESEL) MASTER OF SCIENCE THESIS, JOSÉ CANGA RODRÍGUEZ, INTERNATIONAL MSC IN EVIRONMENTALLY SUSTAINABLE PROCESS TECHNOLOGY, CHALMERS UNIVERSITY OF TECHNOLOGY, 2003. (5) EcoInvent database: published by Swiss Center of Life Cycle Inventories (www.ecoinvent.org).
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Only from production of additives	Input	Resource	Crude oil	9.08985314564428E-02			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Hard coal	2.15446501517639E-03			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Lignite	2.73334547413471E-04			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Natural gas	7.65109484411067E-02			MJ	Ground	
Notes: For the ethanol production (ref 1)	Input	Resource	Primary energy	0.189			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Renewable energy resources	3.82466111291545E-03			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Uranium	9.43947214564627E-03			MJ	Ground	

Notes: Given as kg SO2-eq combined emissions. From production of additives as well as ethanol	Output	Emission	Acidification (AP)	2.91100588218541E-04			kg	Air	
Notes: Given as kg PO4-eq combined emissions. From production of additives as well as ethanol	Output	Emission	Eutrophication (EP)	6.70797143467377E-05			kg	Air	
Notes: Given as kg CO2-eq combined emissions. From production of additives as well as ethanol.	Output	Emission	Global warming (GWP)	2.16314349646461E-02			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Particles (unspecified)	1.05957181609625E-05			kg	Air	
Notes: Given as kg ethene-eq combined emissions. From production of additives as well as ethanol	Output	Emission	Photo-oxidant formation (POCP)	3.96139845015435E-05			kg	Air	
	Output	Product	ED95 from sugar cane	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Hallberg, IVL.
Reviewer	-
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	The data for the ethanol is published in the data set "Ethanol from sugar cane, cradle-to-gate, energy allocation - f3 fuels".

SPINE LCI dataset: ED95 - Wheat, cradle-to-gate, energy allocation - f3 fuels

Administrative

Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System

Name	ED95 - Wheat, cradle-to-gate, energy allocation - f3 fuels
Functional Unit	1 MJ

Functional Unit Explanation	1 MJ output of ED95 fuel from wheat
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of ED95 based on ethanol from wheat. ED95 is an ethanol based fuel used in diesel engines (trucks and buses). In Sweden ED95 is produced by SEKAB, Domsjö, Örnsköldsvik. ED95 can be produced from ethanol from different raw materials such as wheat, suger beat, suger cane etc., but since last year (2012) SEKAB only purchases ethanol from Brazilian suger canes, since it is considered to be the most sustainable. The composition of ED95 is 94 w-% denaturated hydrous ethanol and about 6 w-% water. The rest is additives used as ignition improver, lubricant and denaturants. SEKAB (1) has provided the exact composition and chemical information about the additives as well all relevant physical properties such as densities, heat values and fossil carbon contents. These data are however confidential. Two LCA models of the ED95 fuel was made; based on Brazilian suger cane ethanol and based on ethanol from wheat. The models include the upstream production of the raw materials, but not the ED95 production itself. Since the composition is confidential, only the LCI-results from this model were published in the database. For the production of ethanol (cradle to gate) data from Börjesson 2010 (2) were used for both sugar cane and wheat ethanol. For each ethanol, a scenario with energy alloaction and system expansion are published. Data for the ignition improver and lubricant are produced by AkzoNobel Surface Chemistry (3), who were contacted but in the end they did not provide any data. Instead data were found in a Master thesis performed for AkzoNobel Surface Chemistry (4). Data for the two denaturants were found in the EcoInvent database (5). The data were recalculated from per kg to per MJ of fuel by using a heat value of 25.7 MJ/kg (1). The following processes are covered: - Cultivation of the sugar cane - Harvest - Distribution to the fuel plant - Production of ethanol - Transportation of ethanol from Brazil to a Swedish port Indirect land use change is considered not to occur, as there are no confirmed links under current situation (Berndes et al, 2010 in Börjesson et al 2010). Data in Börjesson et al. are only published as impact categories and not as emissions except for particles. The amount of primary energy is not mentioned either. A case with allocation is made in Börjesson et al. In the f3 fuels data project, data sets both with and without system expansion are published.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Brazil and Europe
Other Boundaries	
Allocations	Allocation is only done in the ethanol production. For the outputs ethanol and the distillers waste energy allocation was applied. Energy contents: wheat 18,4 MJ/kg, distillers waste 17,3 MJ/kg.
Systems Expansions	No.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	N/A

Method	Literature studies of Brazilian ethanol production. General data. For additives site specific data as well as database data have been used.
Literature Reference	(1) SEKAB, Roger Mattebo, personal communication 2013. (2) Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH. (3) AkzoNobel Surface Chemistry, Johanna Martinsson, personal communication 2013. (4) LIFE CYCLE ASSESSMENT OF WOOD-BASED ETHANOL-DIESEL BLENDS (E-DIESEL) MASTER OF SCIENCE THESIS, JOSÉ CANGA RODRÍGUEZ, INTERNATIONAL MSC IN EVIRONMENTALLY SUSTAINABLE PROCESS TECHNOLOGY, CHALMERS UNIVERSITY OF TECHNOLOGY, 2003. (5) EcoInvent database: published by Swiss Center of Life Cycle Inventories (www.ecoinvent.org).
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Only from production of additives	Input	Resource	Crude oil	9.08985314564428E-02			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Hard coal	2.15446501517639E-03			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Lignite	2.73334547413471E-04			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Natural gas	7.65109484411067E-02			MJ	Ground	
Notes: For the ethanol production (ref 1)	Input	Resource	Primary energy	1.4			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Renewable energy resources	3.82466111291545E-03			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Uranium	9.43947214564627E-03			MJ	Ground	
Notes: From production of additives as well as ethanol	Output	Emission	Ammonia	1.05578682905819E-08			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Ammonia	2.27988207580658E-09			kg	Water	
Notes: From production of additives as well as ethanol	Output	Emission	Carbon dioxide (fossil)	1.77286171428671E-02			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Carbon monoxide	1.60809057003922E-05			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Methane (biogenic)	2.17277954380875E-05			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Methane (fossil)	1.07131193301223E-05			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Nitrate	6.80603496685328E-09			kg	Water	
Notes: From production of additives as well as ethanol	Output	Emission	Nitrogen	1.93001642902142E-06			kg	Water	
Notes: From production of additives as well as ethanol	Output	Emission	Nitrogen oxides	6.58742232230357E-05			kg	Air	

Notes: From production of additives as well as ethanol	Output	Emission	Nitrous oxide	1.68363220583774E-05			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Non-methane volatile organic compounds	1.17207619030438E-05			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Particles (unspecified)	7.19695816966329E-06			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Phosphate	1.00924063263647E-07			kg	Water	
Notes: From production of additives as well as ethanol	Output	Emission	Sulfur dioxide	3.4925730913751E-05			kg	Air	
	Output	Product	ED95 from wheat	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Hallberg, IVL.
Reviewer	-
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	The data for the ethanol is published in the data set "Ethanol from wheat, cradle-to-gate, energy allocation - f3 fuels".

SPINE LCI dataset: ED95 - Wheat, cradle-to-gate, system expansion, impact categories only - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	ED95 - Wheat, cradle-to-gate, system expansion, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of ED95 fuel from wheat
Process Type	Cradle to gate

Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of ED95 based on ethanol from wheat. ED95 is an ethanol based fuel used in diesel engines (trucks and buses). In Sweden ED95 is produced by SEKAB, Domsjö, Örnsköldsvik. ED95 can be produced from ethanol from different raw materials such as wheat, suger beat, suger cane etc., but since last year (2012) SEKAB only purchases ethanol from Brazilian suger canes, since it is considered to be the most sustainable. The composition of ED95 is 94 w-% denaturated hydrous ethanol and about 6 w-% water. The rest is additives used as ignition improver, lubricant and denaturants. SEKAB (1) has provided the exact composition and chemical information about the additives as well all relevant physical properties such as densities, heat values and fossil carbon contents. These data are however confidential. Two LCA models of the ED95 fuel was made; based on Brazilian suger cane ethanol and based on ethanol from wheat. The models include the upstream production of the raw materials, but not the ED95 production itself. Since the composition is confidential, only the LCI-results from this model were published in the database. For the production of ethanol (cradle to gate) data from Börjesson 2010 (2) were used for both sugar cane and wheat ethanol. For each ethanol, a scenario with energy alloaction and system expansion are published. Data for the ignition improver and lubricant are produced by AkzoNobel Surface Chemistry (3), who were contacted but in the end they did not provide any data. Instead data were found in a Master thesis performed for AkzoNobel Surface Chemistry (4). Data for the two denaturants were found in the EcoInvent database (5). The data were recalculated from per kg to per MJ of fuel by using a heat value of 25.7 MJ/kg (1). The following processes are covered: - Cultivation of the sugar cane - Harvest - Distribution to the fuel plant - Production of ethanol - Transportation of ethanol from Brazil to a Swedish port Indirect land use change is considered not to occur, as there are no confirmed links under current situation (Berndes et al, 2010 in Börjesson et al 2010). Data in Börjesson et al. are only published as impact categories and not as emissions except for particles. The amount of primary energy is not mentioned either. A case with allocation is made in Börjesson et al. In the f3 fuels data project, data sets both with and without system expansion are published.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Brazil and Europe
Other Boundaries	
Allocations	Distillers waste is generated in the production of ethanol. 1 kg distillers waste (dry matter) is replacing 0.4 kg soybean meal and 0.6 kg barley.
Systems Expansions	No.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	N/A
Method	Literature studies of Brazilian ethanol production. General data. For additives site specific data as well as database data have been used.

Literature Reference	(1) SEKAB, Roger Mattebo, personal communication 2013. (2) Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH. (3) AkzoNobel Surface Chemistry, Johanna Martinsson, personal communication 2013. (4) LIFE CYCLE ASSESSMENT OF WOOD-BASED ETHANOL-DIESEL BLENDS (E-DIESEL) MASTER OF SCIENCE THESIS, JOSÉ CANGA RODRÍGUEZ, INTERNATIONAL MSC IN EVIRONMENTALLY SUSTAINABLE PROCESS TECHNOLOGY, CHALMERS UNIVERSITY OF TECHNOLOGY, 2003. (5) EcoInvent database: published by Swiss Center of Life Cycle Inventories (www.ecoinvent.org).
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Only from production of additives	Input	Resource	Crude oil	9.08985314564428E-02			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Hard coal	2.15446501517639E-03			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Lignite	2.73334547413471E-04			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Natural gas	7.65109484411067E-02			MJ	Ground	
Notes: Not mentioned in the reference for ethanol production (ref 1)	Input	Resource	Primary energy	0			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Renewable energy resources	3.82466111291545E-03			MJ	Ground	
Notes: Only from production of additives	Input	Resource	Uranium	9.43947214564627E-03			MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. From production of additives as well as ethanol	Output	Emission	Acidification (AP)	9.17066687289893E-05			kg	Air	
Notes: Given as kg PO4-eq combined emissions. From production of additives as well as ethanol	Output	Emission	Eutrophication (EP)	3.12039144385797E-05			kg	Air	
Notes: Given as kg CO2-eq combined emissions. From production of additives as well as ethanol.	Output	Emission	Global warming (GWP)	3.07892049412022E-02			kg	Air	
Notes: From production of additives as well as ethanol	Output	Emission	Particles (unspecified)	4.17583817739736E-06			kg	Air	
Notes: Given as kg ethene-eq combined emissions. From production of additives as well as ethanol	Output	Emission	Photo-oxidant formation (POCP)	8.60218778093367E-06			kg	Air	
	Output	Product	ED95 from wheat	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Hallberg, IVL.
Reviewer	-

Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	The data for the ethanol is published in the data set "Ethanol from wheat, cradle-to-gate, energy allocation - f3 fuels".

SPINE LCI dataset: ED95 combustion in heavy duty truck or bus with a diesel engine, Euro V, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	ED95 combustion in heavy duty truck or bus with a diesel engine, Euro V, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of ED95 fuel to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from ED95 combustion in a diesel engine in heavy duty truck or bus, Euro V, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data

General Activity QMetaData	
Date Conceived	
Data Type	
Represents	N/A
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on ETC (transient test cycle for truck and bus engines), legislation limits for Euro V (2005/55/EC). The ETC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.43 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) for a diesel engine and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.
Literature Reference	Main references: (1) 2005/55/EC (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) SEKAB, Roger Mattebo, personal communication 2013. (5) Dir 2009/30/EC
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Product	ED95	1			MJ	Technosphere	
Method: The composition of ED95 is 94 w-% denaturated hydrous ethanol and about 6 w-% water. The rest is additives used as ignition improver, corrosion inhibitor and lubricants. The producer of ED95 (SEKAB) has provided the exact composition and chemical information about the additives as well all relevant physical properties such as densities, heat values and fossil carbon content. These data are however confidential. From these data an average fossil carbon content of 5.11 w-% was derived. The heat value of ED95 is 25.7 MJ/kg. Recalculating to per MJ of fuel, 0.00729 kg of fossil CO2 per MJ is obtained (1 kg of C generates 3.67 kg of CO2). Literature: SEKAB	Output	Emission	Carbon dioxide (fossil)	0.00729			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Carbon monoxide	4.77777777777778E-04			kg	Air	
Method: 10% of THC according to JRC (2013). Literature: JRC (2013)	Output	Emission	Methane	6.56944444444445E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Nitrogen oxides	2.38888888888889E-04			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited	Output	Emission	Nitrous oxide	6.11111111111111E-06			kg	Air	

data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.									
Method: THC minus CH4. Literature: THC is from limit in Euro V legislation	Output	Emission	Non-methane volatile organic compounds	0.000059125			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Particles (unspecified)	3.58333333333333E-06			kg	Air	
Method: The legislative limit is 10 mg/kg (10 ppm) (Dir 2009/30/EC), but here a typical value is chosen. 1 kg of S generates 2 kg of SO2. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 25.7 MJ/kg. Literature: Typical value	Output	Emission	Sulfur dioxide	2.33463035019455E-07			kg	Air	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: ED95 combustion in heavy duty truck or bus with a diesel engine, Euro VI, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System

Name	ED95 combustion in heavy duty truck or bus with a diesel engine, Euro VI, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of ED95 fuel to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on WHTC (World Harmonized Transient Cycle for truck and bus engines), legislation limits for Euro VI (Commission Regulation (EC) No 582/2011).The WHTC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.43 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) for a diesel engine and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	N/A
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on WHTC (World Harmonized Transient Cycle for truck and bus engines), legislation limits for Euro VI (Commission Regulation (EC) No 582/2011).The WHTC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.43 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) for a diesel engine and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.
Literature Reference	Main references: (1) Commission Regulation (EC) No 582/2011 (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) SEKAB, Roger Mattebo, personal communication 2013. (5) Dir 2009/30/EC
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***

	Input	Product	ED95	1			MJ	Technosphere	
Method: The composition of ED95 is 94 w-% denaturated hydrous ethanol and about 6 w-% water. The rest is additives used as ignition improver, corrosion inhibitor and lubricants. The producer of ED95 (SEKAB) has provided the exact composition and chemical information about the additives as well all relevant physical properties such as densities, heat values and fossil carbon content. These data are however confidential. From these data an average fossil carbon content of 5.11 w-% was derived. The heat value of ED95 is 25.7 MJ/kg. Recalculating to per MJ of fuel, 0.00729 kg of fossil CO_2 per MJ is obtained (1 kg of C generates 3.67 kg of CO_2). Literature: SEKAB	Output	Emission	Carbon dioxide (fossil)	0.00729			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Carbon monoxide	4.77777777777778E-04			kg	Air	
Method: 10% of THC according to JRC (2013). Literature: JRC (2013)	Output	Emission	Methane	1.91111111111111E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Nitrogen oxides	5.49444444444444E-05			kg	Air	
Method: Emissions of N_2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N_2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	6.11111111111111E-06			kg	Air	
Method: THC minus CH_4. Literature: THC is from limit in Euro VI legislation	Output	Emission	Non-methane volatile organic compounds	0.0000172			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Particles (unspecified)	1.19444444444444E-06			kg	Air	
Method: The legislative limit is 10 mg/kg (10 ppm) (Dir 2009/30/EC), but here a typical value is chosen. 1 kg of S generates 2 kg of SO_2. The heat value used for calculation to SO_2 from per kg fuel to per MJ fuel was 25.7 MJ/kg. Literature: Typical value	Output	Emission	Sulfur dioxide	2.33463035019455E-07			kg	Air	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Electric freight train, waggon load

Administrative	
Finished	Y
Date Completed	99 - 11 -
Copyright	NTM
Availability	The data is publically available.

Technical System	
Name	Electric freight train, waggon load
Functional Unit	1 tonkm 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a waggon load freight train with an RC engine. Electrically driven waggon load freight train is the traditional freight train used in Sweden. Different types of waggons and aimed for different destinations are connected and pulled by one single engine. The waggons are connected and deconnected during the route to their final destinations. The operation includes: -Propulsion (including auxiliary machinery and safety systems) -Comfort during the journey -Complimentary runs -Stationary vehicle heating -Operation of fixed installations (not including heating of premises)

System Boundaries	
Nature Boundary	-Emissions to air have not been included. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.

Time Boundary	The data represents the fleet in 1999.
Geographical Boundary	The data is based on Swedish conditions
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. Parameters not considered -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc -Use of lubricating oil -Wear of brake lining, rail and wheel, areal line and collector shoe Excluded subsystems -Electricity production -Maintenence of the engine -Aftertreatement of the engine - Handling of production rests - Manufacturing of vehicles and other equipment - Heating of buildings serving the transportation system - Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1999 - 11
Data Type	Random samples
Represents	NTM
Method	The electricity consumption is based on measurements on 6000 freight trains in regular traffic conducted between 1994 and 1998 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The electricity consumption per tonkm was calculated using an load factor of 46%. The *quantity value* refers to an average of the energy use of the studied trains. The *minimum and maximum value* refers to the minimum and the maximum value obtained by the measurements. Current and voltage were measured in the trains tractive units (locomotive or motor coach), at the energy input close to the current collector. Additions were then made for losses in the railways supply system. The results thus obtained give electrical energy consumption per gross-tonne-km reckoned in power outtake from the national grid. The energy use was calculated per net-tonne-km as a function of the trains capacity and load factor. The losses in the railway supply system include losses in converters and catenary cables (efficiency 81,8% for supply to RC locomotives) and losses suffered in transmitting electricity from the power station to the feed-in point (the losses are assumed to be approx. 4 %) For further details see Andersson. The load factor that was used in the calculations is a representative mean value for different types of freight traffic, based on statistics from the State Railways Freight Transportation Division and State Railways Financial department. For the whole of State Railways Freight traffic, excluding iron-ore transport, the mean load factor was about 46% in 1993. (Load factor=net-tonne/gross-tonne where the gross-tonne concept refer to train weight, including locomotive freight wagons and load. The net-tonne concept refers to payload after the weight of the locomotive and wagons have been excluded.)
Literature Reference	Andersson, E., ''Energy consumption and air pollution of electric rail traffic, The Swedish case'', TRITA-FKT, Report 9446, Railway Technlogy, Department of Vehicle Engineering, Royal Institute of Technology, 1994.
Notes	The minimum and maximum value is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Electricity	0.042	0.02	0.076	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden

About Inventory

Publication	www.ntm.a.se Data Documented by Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology

Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Strömberg, Jonas - SJ Cargo Group, Stockholm .
Reviewer	
Applicability	The data should not be used for detailed studies of transportation activities. More detailed data is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information in these matters. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used. Electrically driven trains transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transported by combi trains are about 5 % of the total amount of goods transported by electrically driven trains. Electrically driven system trains are not recoupled on the way and always take the same route between two adresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is about 50 % or higher. System trains ordinarily runs special transportation assignments for different types of industry. Diesel driven engines (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the swedish railway system that are not electrified. SJ also uses smaller diesel engines (V5) for shunting. The V5 engine has a capacity of 400-500 tonnes gross weight and is not used for regular traffic. -- Marshalling -- The major part of the goods is marshalled at 6 main junctions where the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (vallväxling) -Fly shunting (planväxling) -- Distance -- The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ has developed an environmentl data software with a databas of distances between 70 different places, concidering the infrastructure. The database does however not give information on which lines that arenot electrified. -- Bulky goods --

	The data can be used for bulcy goods with the recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. -- Emissions from electricity production -- When using the data, the electricity production should be included, especially when comparing different modes of transportation. The emissions from electricity production can be calculated from the mix of electricity production processes that the electricity supplyers have that supplies SJ with electricity. SJ buys exclusivally ''ecolabelled'' electricity, i.e. hydro power with the following emission data (Brännström-Norberg et al., 1996): CO_2: 0,0677 (g/kWh electr.) NO_x: 0,000263 SO_2: 0,000109 CO: 0,0018 Particl.: 0,0000295 HC: 0,000247 NTM has agreed on this way of calculating if the supplyer and buyer have a contract. References: Brännström-Norberg B-M et al (1996). ''Livscykelanalys för Vattenfalls Elproduktion - Sammanfattande rapport'', Vattenfall, Stockholm
About Data	.***Electricity consumption*** The electricity consumption was obtained by energy studies of 6000 trains in regular traffic, including losses in the railway supply system. Several parameters thus influence the energy use, such as e.g. topography, driving technique, the number of starts and stops, number of passing, the trains composition of trucks regarding aerodynamics and the weight of the train etc. The electricity consumption is roughly proportional to the weight of the train. Consequently, the electricity consumption per tonkm for a given utilisation level is approximately constant, independent on the size of the train. ***Utilisation level*** For electrically driven goods trains, the data is based on an average utilisation level of 46 % (including transportation of empty trucks). The average utilisation level was based on statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively. The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation.
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by train in NTM.Data is collected from NTM homepage, latest updated 1999 - 11 - 11. The data is continously updated and the user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: www.ntm.a.se The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation.Updated data for diesel trains and road transport are expected to be published before summer 2000. The major Swedish actors in the transportation business, which are members of NTM (e.g., SJ, BTL, ASG, etc.), will use the data as a basis for environmental assessment of different transportation alternatives.

SPINE LCI dataset: Electric freight train, waggon load, including electricity production

Administrative	
Finished	Y
Date Completed	99 - 11 -
Copyright	NTM
Availability	The data is publically available.

Technical System

Name	Electric freight train, waggon load, including electricity production
Functional Unit	1 tonkm 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a waggon load freight train with an RC engine, including production of electricity used in the transport. Electrically driven waggon load freight train is the traditional freight train used in Sweden. Different types of waggons and aimed for different destinations are connected and pulled by one single engine. The waggons are connected and deconnected during the route to their final destinations. The operation includes: -Propulsion (including auxiliary machinery and safety systems) -Comfort during the journey -Complimentary runs -Stationary vehicle heating -Operation of fixed installations (not including heating of premises) The production of electricity includes fuel production, operation and maintenance of hydro power. SJ buys exclusively ''ecolabelled'' electricity, i.e. hydro power.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: - Regulated emissions for diesel engines: NOx, HC, particles and CO - Fuel regulated: SO2 - Tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1999
Geographical Boundary	The data is based on Swedish conditions
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. Parameters not considered -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc -Use of lubricating oil -Wear of brake lining, rail and wheel, areal line and collector shoe Excluded subsystems -Maintenence of the engine -Aftertreatement of the engine - Handling of production rests - Manufacturing of vehicles and other equipment - Heating of buildings serving the transportation system - Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1999 - 11
Data Type	Random samples
Represents	NTM
Method	The electricity consumption is based on measurements on 6000 freight trains in regular traffic conducted between 1994 and 1998 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The electricity consumption per tonkm was calculated using an load factor of 46%. The *quantity value* refers to an average

	of the energy use of the studied trains. The *minimum and maximum value* refers to the minimum and the maximum value obtained by the measurements. Current and voltage were measured in the trains tractive units (locomotive or motor coach), at the energy input close to the current collector. Additions were then made for losses in the railways supply system. The results thus obtained give electrical energy consumption per gross-tonne-km reckoned in power outtake from the national grid. The energy use was calculated per net-tonne-km as a function of the trains capacity and load factor. The losses in the railway supply system include losses in converters and catenary cables (efficiency 81,8% for supply to RC locomotives) and losses suffered in transmitting electricity from the power station to the feed-in point (the losses are assumed to be approx. 4 %) For further details see Andersson. The load factor that was used in the calculations is a representative mean value for different types of freight traffic, based on statistics from the State Railways Freight Transportation Division and State Railways Financial department. For the whole of State Railways Freight traffic, excluding iron-ore transport, the mean load factor was about 46% in 1993. (Load factor=net-tonne/gross-tonne where the gross-tonne concept refer to train weight, including locomotive freight wagons and load. The net-tonne concept refers to payload after the weight of the locomotive and wagons have been excluded.) ***Emissions from electricity production*** The emissions from electricity production are calculated after the mix of electricity production processes that the electricity supplyers have that supplies SJ with electricity. SJ buys exclusivally ''ecolabelled'' electricity, i.e. hydro power. The with the following emission factors have been used (Brännström-Norberg et al., 1996): CO2: 0,0677 (g/kWh electr.) NOx: 0,000263 SO2: 0,000109 CO: 0,0018 Particl.: 0,0000295 HC: 0,000247 NTM has agreed on this way of calculating if the supplier and buyer have a contract.
Literature Reference	Brännström-Norberg B-M., et al, Livscykelanalys för Vattenfalls elproduktion Sammanfattande rapport, Vattenfall, 1996. Buhre M., Eriksson Å., Livscykelanalys för kolkraft, Linköping Institute of Technology and Uppsala University, 1997 Andersson, E., ''Energy consumption and air pollution of electric rail traffic, The Swedish case'', TRITA-FKT, Report 9446, Railway Technlogy, Department of Vehicle Engineering, Royal Institute of Technology, 1994.
Notes	The minimum and maximum value for the electricity consumption is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Electricity	0.042	0.02	0.076	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.00008			g	Air	Sweden
	Output	Emission	CO2	0.003			g	Air	Sweden
	Output	Emission	HC	0.00001			g	Air	Sweden
	Output	Emission	NOx	0.00001			g	Air	Sweden
	Output	Emission	Particles	0.000001			g	Air	Sweden
	Output	Emission	SO2	0.000005			g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data Documented by Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation

Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Strömberg, Jonas - SJ Cargo Group, Stockholm .
Reviewer	
Applicability	The data should not be used for detailed studies of transportation activities. More detailed data is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information in these matters. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used. Electrically driven trains transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transported by combi trains are about 5 % of the total amount of goods transported by electrically driven trains. Electyrically driven system trains are not recoupled on the way and always take the same route between two adresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is about 50 % or higher. System trains ordinarily runs special transportation assignments for different types of industry. Diesel driven engines (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the swedish railway system that are not electrified. SJ also uses smaller diesel engines (V5) for shunting. The V5 engine has a capacity of 400-500 tonnes gross weight and is not used for regular traffic. -- Marshalling -- The major part of the goods is marshalled at 6 main junctions where the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (valväxling) -Fly shunting (planväxling) -- Distance -- The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ has developed an environmentl data software with a databas of distances between 70 different places, concidering the infrastructure. The database does however not give information on which lines that arenot electrified. -- Bulky goods -- The data can be used for bulcy goods with the recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.
About Data	.***Electricity consumption*** The electricity consumption was obtained by energy studies of 6000 trains in regular traffic, including losses in the railway supply system. Several parameters thus influence the energy use, such as e.g. topography, driving technique, the number of starts and stops, number of passing, the trains composition of trucks regarding aerodynamics and the weight of the train etc. The electricity consumption is roughly proportional to the weight of the train. Consequently, the electricity consumption per tonkm for a given utilisation level is approximately constant, independent on the size of the train. ***Utilisation level*** For electrically driven goods trains, the data is based on an average utilisation level of 46 % (including transportation of empty trucks). The average utilisation level was based on statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively.

	The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation. ***Emissions from electricity production*** The emissions from electricity production are calculated from the mix of electricity production processes that the electricity supplyers have that supplies SJ with electricity. SJ buys exclusivally ''ecolabelled'' electricity, i.e. hydro power. The following emission data has been used (Brännström-Norberg et al., 1996): CO2: 0,0677 (g/kWh electr.) NOx: 0,000263 SO2: 0,000109 CO: 0,0018 Particl.: 0,0000295 HC: 0,000247 NTM has agreed on this way of calculating if the supplyer and buyer have a contract.
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by train in NTM. Data is collected from NTM homepage, latest updated 1999 - 11 - 11. The data is continously updated and the user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: www.ntm.a.se The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation.Updated data for diesel trains and road transport are expected to be published before summer 2000. The major Swedish actors in the transportation business, which are members of NTM (e.g., SJ, BTL, ASG, etc.), will use the data as a basis for environmental assessment of different transportation alternatives.

SPINE LCI dataset: Electrically driven combi train, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Electrically driven combi train, future
Functional Unit	1 tonkm, 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation, i.e. propulsion of an electrically driven combi train, assuming different energy saving measures on the existing system (rebuilding trains). The aim is to get a picture of future energy use of electric train traffic. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck.

System Boundaries

Nature Boundary	Diffuse emissions to air and emissions to water and ground, noise, encroachment and other environmental impacts have not been considered.
Time Boundary	The data represents an assessment of future energy use and emissions of electric train traffic.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc. -Use of lubricating oil -Wear of brake lining, rail and wheel, aerial line and collector shoe *Excluded subsystems* -Electricity production -Maintenance of the engine -After-treatment of the engine -Handling of production rests -Manufacturing of vehicles and other equipment -Heating of buildings serving the transportation system -Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The electricity consumption was calculated using the assumption that the energy use may be reduced by 35 % by new engines and rebuilding existing engines together with data for existing trains in regular traffic with the lowest energy use. The assumption was based on Andersson. The electricity consumption per tonkm was calculated using an load factor of 46%. The data for trains in use in regular traffic today can be found in the activity ObjectOfStudy.Name: Electrically driven goods train 700 metres, RC engine (in this database)or in NGM. The minimum value for the energy use was used in the calculation. The data is based on measurements on freight trains in regular traffic conducted between 1994 and 1997 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The data includes losses in the railway supply system.
Literature Reference	Andersson, E., 'Future Energy Consumption of the Railways' (in Swedish), TRITA-FKT 1996:49, Railway Technology, Department of Vehicle Engineering, Royal Institute of Technology, 1994. NGM (Nätverket för Godstransporter och Miljön) Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997, NGM, (In Swedish) 1997
Notes	The minimum and maximum value for the electricity consumption is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Electricity	0.097			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Ingela Melkersson, SJ Stab Information, contact person for rail transports in the work of NGM --

Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Trouve, Johan - SJ (Swedish State Railways), Stab Information, Box 1522, 401 50 Göteborg.
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions for Swedish train traffic. The data represents best available technology not yet in use.
About Data	***Electricity consumption*** The electricity consumption was based on assumptions that the energy use in the existing system may be reduced by 35% by different energy saving measures, rebuilding existing engines and new engines. ***Emissions from electricity production*** When using the data, the electricity production should be included, especially when comparing different modes of transportation. SJ and NGM propose that the following data for average Swedish electricity production should be used to calculate the emissions from electricity production: -NOx: 0,038 g/kWh produced electricity -S: 0,021 g/kWh produced electricity -CO: 0,023 g/kWh produced electricity -HC: 0,0003 g/kWh produced electricity -CO2: 20,8 g/kWh produced electricity The data was given by Vattenfall AB and concern the Swedish electricity production in 1993. The following production methods were used: Hydro-electric power (52%), Nuclear power (42%), Wind power (0,04%), Thermal power (6%) where 2% is fuelled by fossil fuels. Today, SJ buys electricity from Vattenfall and Tälje energi
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Electrically driven combi train, RC engine

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Electrically driven combi train, RC engine
Functional Unit	1 tonkm, 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a combi train with an RC engine. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck. The operation includes: -Propulsion (including auxiliary machinery and safety systems) -Comfort during the journey -Complimentary runs -Stationary vehicle heating -Operation of fixed installations (not including heating of premises) Maximum gross weight of the train: 1500 tonnes. Maximum loading capacity with regard to weight: 1031 tonnes.

System Boundaries	
Nature Boundary	Diffuse emissions to air and emissions to water and ground, noise, encroachment and other environmental impacts have not been considered.
Time Boundary	The data represents the fleet in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc. -Use of lubricating oil -Wear of brake lining, rail and wheel, aerial line and collector shoe *Excluded subsystems* -Electricity production -Maintenance of the engine -After-treatment of the engine -Handling of production rests -Manufacturing of vehicles and other equipment -Heating of buildings serving the transportation system -Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1994-01-01 - 1997-01-01
Data Type	Random samples
Represents	NTM
Method	The electricity consumption is based on measurements on 6000 freight trains in regular traffic conducted between 1994 and 1997 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The electricity consumption per tonkm was calculated using an load factor of 46%. The *quantity value* refers to an average of the energy use of the studied trains. The *minimum and maximum value* refers to the minimum and the maximum value obtained by the measurements. Current and voltage were measured in the trains tractive units (locomotive or motor coach), at the energy input close to the current collector. Additions were then made for losses in the railways supply system. The results thus obtained give electrical energy consumption per gross-tonne-km reckoned in power outtake from the national grid. The energy use was calculated per net-tonne-km as a function of the trains capacity and load factor. The losses in the railway supply system include losses in converters and catenary cables (efficiency 81,8% for supply to RC locomotives) and losses suffered in transmitting electricity from the power station to the feed-in point (the losses are assumed to be approx. 4 %) For further details see Andersson. The load factor that was used in the calculations is a representative mean value for different types of freight traffic, based on statistics from the State Railways Freight Transportation Division and State Railways Financial department. For the whole of State Railways Freight traffic, excluding iron-ore transport, the mean load factor was about 46% in 1993. (Load factor=net-tonne/gross-tonne where the gross-tonne concept refer to train weight, including locomotive freight wagons and load. The net-tonne concept refers to payload after the weight of the locomotive and wagons have been excluded.)
Literature Reference	Andersson, E., ''Energy consumption and air pollution of electric rail traffic, The Swedish case'', TRITA-FKT, Report 9446, Railway Technlogy, Department of Vehicle Engineering, Royal Institute of Technology, 1994.
Notes	The minimum and maximum value is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Electricity	0.15	0.13	0.17	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Ingela Melkersson, SJ Stab Information, contact person for rail transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives.

	The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Trouve, Johan - SJ (Swedish State Railways), Stab Information, Box 1522, 401 50 Göteborg.
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information on how the goods are handled and the transport is carried out. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used: *Electrically driven freight trains* transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. *Electrically driven combi train* consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transportation by combi train is about 5 % of the total transportation by electrically driven goods trains. *Electrically driven system trains* are not recoupled on the way and always take the same route between two addresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is 50% or higher. System trains ordinarily runs special transportation assignments for different types of industry. *Diesel driven engines* (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the Swedish railway system that are not electrified. SJ also uses a smaller diesel driven engine (V5) for shunting. The V5 engine has a capacity of 450-500 tonnes gross weight and is not ordinarily used for regular traffic. ***Marshalling*** The major part of the goods is marshalled at 6 main junctions were the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (vallväxling) -Fly shunting (planväxling) ***Distance*** The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ (Swedish State Railways) has developed environmental data software with a database of distances between 70 different places, considering the infrastructure. The database does however not give information on which lines that are not electrified. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***International train traffic*** The data for the electricity consumption use may be used for train transports in Europe, since the technique in other countries are similar (electrically and diesel driven engines). The handling of the goods may however differ in different countries, e.g. regarding average utilisation level etc. Also, the electricity production in different countries varies.
About Data	***Electricity consumption*** The electricity consumption was obtained by energy studies of 6000 trains in regular traffic, including losses in the railway supply system. Several parameters thus influence the energy use, such as e.g. topography, driving technique, the number of starts and stops, number of passing, the trains composition of trucks regarding aerodynamics and the weight of the train etc. The electricity consumption is roughly proportional to the weight of the train. Consequently, the electricity consumption per tonkm for a given utilisation level is approximately constant, independent on the size of the train. ***Utilisation level*** For electrically driven goods trains, the data is based on an average utilisation level of 46 % (including transportation of empty trucks). The average utilisation level was based on statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains

	more effectively. The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation. ***Emissions from electricity production*** When using the data, the electricity production should be included, especially when comparing different modes of transportation. SJ and NGM propose that the following data for average Swedish electricity production should be used to calculate the emissions from electricity production: -NOx: 0,038 g/kWh produced electricity -S: 0,021 g/kWh produced electricity -CO: 0,023 g/kWh produced electricity -HC: 0,0003 g/kWh produced electricity -CO2: 20,8 g/kWh produced electricity The data was given by Vattenfall AB and concern the Swedish electricity production in 1993. The following production methods were used: Hydro-electric power (52%), Nuclear power (42%), Wind power (0,04%), Thermal power (6%) where 2% is fuelled by fossil fuels. Today, SJ buys electricity from Vattenfall and Tälje energi.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Electrically driven freight train 230 metres, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Electrically driven freight train 230 metres, future
Functional Unit	1 tonkm, 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden

Technical system description	Operation, i.e. propulsion of an electrically driven freight train, 230 metres, assuming different energy saving measures on the existing system (rebuilding trains etc.). The aim is to get a picture of future energy use of electric train traffic. Electrically driven freight trains transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes.

System Boundaries

Nature Boundary	Diffuse emissions to air and emissions to water and ground, noise, encroachment and other environmental impacts have not been considered.
Time Boundary	The data represents an assessment of future energy use and emissions of electric train traffic.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc. -Use of lubricating oil -Wear of brake lining, rail and wheel, aerial line and collector shoe *Excluded subsystems* -Electricity production -Maintenance of the engine -After-treatment of the engine -Handling of production rests -Manufacturing of vehicles and other equipment -Heating of buildings serving the transportation system -Erection and maintenance of infrastructure
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The electricity consumption was calculated using the assumption that the energy use may be reduced by 35 % by new engines and rebuilding existing engines together with data for existing trains in regular traffic with the lowest energy use. The assumption was based on Andersson. The electricity consumption per tonkm was calculated using an load factor of 46%. The data for trains in use in regular traffic today can be found in the activity ObjectOfStudy.Name: Electrically driven goods train 700 metres, RC engine (in this database)or in NGM. The minimum value for the energy use was used in the calculation. The data is based on measurements on freight trains in regular traffic conducted between 1994 and 1997 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The data includes losses in the railway supply system.
Literature Reference	Andersson, E., 'Future Energy Consumption of the Railways' (in Swedish), TRITA-FKT 1996:49, Railway Technology, Department of Vehicle Engineering, Royal Institute of Technology, 1994. NGM (Nätverket för Godstransporter och Miljön) Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997, NGM, (In Swedish) 1997
Notes	The minimum and maximum value is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Electricity	0.054			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Ingela Melkersson, SJ Stab Information, contact person for rail transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Trouve, Johan - SJ (Swedish State Railways), Stab Information, Box 1522, 401 50 Göteborg.
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions for Swedish train traffic. The data represents new technology not yet in use.
About Data	***Electricity consumption*** The electricity consumption was based on assumptions that the energy use in the existing system may be reduced by 35% by different energy saving measures, rebuilding existing engines and new engines. ***Emissions from electricity production*** When using the data, the electricity production should be included, especially when comparing different modes of transportation. SJ and NGM propose that the following data for average Swedish electricity production should be used to calculate the emissions from electricity production: -NOx: 0,038 g/kWh produced electricity -S: 0,021 g/kWh produced electricity -CO: 0,023 g/kWh produced electricity -HC: 0,0003 g/kWh produced electricity -CO2: 20,8 g/kWh produced electricity The data was given by Vattenfall AB and concern the Swedish electricity production in 1993. The following production methods were used: Hydro-electric power (52%), Nuclear power (42%), Wind power (0,04%), Thermal power (6%) where 2% is fuelled by fossil fuels. Today, SJ buys electricity from Vattenfall and Tälje energi.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different

	transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Electrically driven freight train 230 metres, RC engine

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Electrically driven freight train 230 metres, RC engine
Functional Unit	1 tonkm, 46%
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of freight train with an electrically driven RC engine. Electrically driven freight trains transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The operation includes -Propulsion (including auxiliary machinery and safety systems) -Comfort during the journey -Complimentary runs -Stationary vehicle heating -Operation of fixed installations (not including heating of premises) Maximum gross weight of the train: 500 tonnes. Maximum loading capacity with regard to weight: 344 tonnes.

System Boundaries	
Nature Boundary	Diffuse emissions to air and emissions to water and ground, noise, encroachment and other environmental impacts have not been considered.
Time Boundary	The data represents the fleet in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc. -Use of lubricating oil -Wear of brake lining, rail and wheel, aerial line and collector shoe *Excluded subsystems*

	-Electricity production -Maintenance of the engine -After-treatment of the engine -Handling of production rests -Manufacturing of vehicles and other equipment -Heating of buildings serving the transportation system -Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1994-01-01 - 1997-01-01
Data Type	Random samples
Represents	NTM
Method	The electricity consumption is based on measurements on 6000 freight trains in regular traffic conducted between 1994 and 1997 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The electricity consumption per tonkm was calculated using an load factor of 46%. The *quantity value* refers to an average of the energy use of the studied trains. The *minimum and maximum value* refers to the minimum and the maximum value obtained by the measurements. Current and voltage were measured in the trains tractive units (locomotive or motor coach), at the energy input close to the current collector. Additions were then made for losses in the railways supply system. The results thus obtained give electrical energy consumption per gross-tonne-km reckoned in power outtake from the national grid. The energy use was calculated per net-tonne-km as a function of the trains capacity and load factor. The losses in the railway supply system include losses in converters and catenary cables (efficiency 81,8% for supply to RC locomotives) and losses suffered in transmitting electricity from the power station to the feed-in point (the losses are assumed to be approx. 4 %) For further details see Andersson. The load factor that was used in the calculations is a representative mean value for different types of freight traffic, based on statistics from the State Railways Freight Transportation Division and State Railways Financial department. For the whole of State Railways Freight traffic, excluding iron-ore transport, the mean load factor was about 46% in 1993. (Load factor=net-tonne/gross-tonne where the gross-tonne concept refer to train weight, including locomotive freight wagons and load. The net-tonne concept refers to payload after the weight of the locomotive and wagons have been excluded).
Literature Reference	Andersson, E., ''Energy consumption and air pollution of electric rail traffic, The Swedish case'', TRITA-FKT, Report 9446, Railway Technlogy, Department of Vehicle Engineering, Royal Institute of Technology, 1994.
Notes	The minimum and maximum value is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Electricity	0.15	0.072	0.27	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Ingela Melkersson, SJ Stab Information, contact person for rail transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business.

	The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Trouve, Johan - SJ (Swedish State Railways), Stab Information, Box 1522, 401 50 Göteborg.
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information on how the goods are handled and the transport is carried out. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used: *Electrically driven freight trains* transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. *Electrically driven combi train* consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transportation by combi train is about 5 % of the total transportation by electrically driven goods trains. *Electrically driven system trains* are not recoupled on the way and always take the same route between two addresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is 50% or higher. System trains ordinarily runs special transportation assignments for different types of industry. *Diesel driven engines* (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the Swedish railway system that are not electrified. SJ also uses a smaller diesel driven engine (V5) for shunting. The V5 engine has a capacity of 450-500 tonnes gross weight and is not ordinarily used for regular traffic. ***Marshalling*** The major part of the goods is marshalled at 6 main junctions were the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (vallväxling) -Fly shunting (planväxling) ***Distance*** The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ (Swedish State Railways) has developed environmental data software with a database of distances between 70 different places, considering the infrastructure. The database does however not give information on which lines that are not electrified. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***International train traffic*** The data for the electricity use may be used for train transports in Europe, since the technique in other countries are similar (electrically and diesel driven engines). The handling of the goods may however differ in different countries, e.g. regarding average utilisation level etc. Also, the electricity production in different countries varies.

About Data	The electricity consumption was obtained by energy studies of 6000 trains in regular traffic, including losses in the railway supply system. Several parameters thus influence the energy use, such as e.g. topography, driving technique, the number of starts and stops, number of passing, the trains composition of trucks regarding aerodynamics and the weight of the train etc. The electricity consumption is roughly proportional to the weight of the train. Consequently, the electricity consumption per tonkm for a given utilisation level is approximately constant, independent on the size of the train. ***Utilisation level*** For electrically driven goods trains, the data is based on an average utilisation level of 46 % (including transportation of empty trucks). The average utilisation level was based on statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively. The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation. ***Emissions from electricity production*** When using the data, the electricity production should be included, especially when comparing different modes of transportation. SJ and NGM propose that the following data for average Swedish electricity production should be used to calculate the emissions from electricity production: -NOx: 0,038 g/kWh produced electricity -S: 0,021 g/kWh produced electricity -CO: 0,023 g/kWh produced electricity -HC: 0,0003 g/kWh produced electricity -CO2: 20,8 g/kWh produced electricity The data was given by Vattenfall AB and concern the Swedish electricity production in 1993. The following production methods were used: Hydro-electric power (52%), Nuclear power (42%), Wind power (0,04%), Thermal power (6%) where 2% is fuelled by fossil fuels. Today, SJ buys electricity Vattenfall and Tälje energi.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Electrically driven freight train 700 metres, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Electrically driven freight train 700 metres, future

Functional Unit	1 tonkm, 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation, i.e. propulsion of an electrically driven freight train, 700 metres, assuming different energy saving measures on the existing system (rebuilding trains etc.). The aim is to get a picture of future energy use of electric train traffic. Electrically driven freight trains transport 95% of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes.

System Boundaries

Nature Boundary	Diffuse emissions to air and emissions to water and ground, noise, encroachment and other environmental impacts have not been considered.
Time Boundary	The data represents an assessment of future energy use and emissions of electric train traffic.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc. -Use of lubricating oil -Wear of brake lining, rail and wheel, aerial line and collector shoe *Excluded subsystems* -Electricity production -Maintenance of the engine -After-treatment of the engine -Handling of production rests -Manufacturing of vehicles and other equipment -Heating of buildings serving the transportation system -Erection and maintenance of infrastructure
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The electricity consumption was calculated using the assumption that the energy use may be reduced by 35 % by new engines and rebuilding existing engines together with data for existing trains in regular traffic with the lowest energy use. The assumption was based on Andersson. The electricity consumption per tonkm was calculated using an load factor of 46%. The data for trains in use in regular traffic today can be found in the activity ObjectOfStudy.Name: Electrically driven goods train 700 metres, RC engine (in this database)or in NGM. The minimum value for the energy use was used in the calculation. The data is based on measurements on freight trains in regular traffic conducted between 1994 and 1997 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The data includes losses in the railway supply system.
Literature Reference	Andersson, E., 'Future Energy Consumption of the Railways' (in Swedish), TRITA-FKT 1996:49, Railway Technology, Department of Vehicle Engineering, Royal Institute of Technology, 1994. NGM (Nätverket för Godstransporter och Miljön) Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997, NGM, (In Swedish) 1997

Notes	The minimum and maximum value is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Electricity	0.054			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Ingela Melkersson, SJ Stab Information, contact person for rail transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Trouve, Johan - SJ (Swedish State Railways), Stab Information, Box 1522, 401 50 Göteborg.
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions for Swedish train traffic. The data represents new technology not yet in use.
About Data	***Electricity consumption*** The electricity consumption was based on assumptions that the energy use in the existing system may be reduced by 35% by different energy saving measures, rebuilding existing engines and new engines. ***Emissions from electricity production*** When using the data, the electricity production should be included, especially when comparing different modes of transportation. SJ and NGM propose that the following data for average Swedish electricity production should be used to calculate the emissions from electricity production: -NOx: 0,038 g/kWh produced electricity -S: 0,021 g/kWh produced electricity -CO: 0,023 g/kWh produced electricity -HC: 0,0003 g/kWh produced electricity -CO2: 20,8 g/kWh produced electricity The data was given by Vattenfall AB and concern the Swedish electricity production in 1993. The following production methods were used: Hydro-electric power (52%), Nuclear power (42%), Wind power (0,04%), Thermal power (6%) where 2% is fuelled by fossil fuels.

	Today, SJ buys electricity from Vattenfall and Tälje energi.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Electrically driven freight train 700 metres, RC engine

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Electrically driven freight train 700 metres, RC engine
Functional Unit	1 tonkm, 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of freight train with an electrically driven RC engine. Electrically driven freight trains transport the major part of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The operation includes -Propulsion (including auxiliary machinery and safety systems) -Comfort during the journey -Complimentary runs -Stationary vehicle heating -Operation of fixed installations (not including heating of premises) Maximum gross weight of the train: 1500 tonnes. Maximum loading capacity with regard to weight: 1031 tonnes.

System Boundaries

Nature Boundary	Diffuse emissions to air and emissions to water and ground, noise, encroachment and other environmental impacts have not been considered.
Time Boundary	The data represents the fleet in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc. -Use of lubricating oil -Wear of brake lining, rail and wheel, aerial line and collector shoe *Excluded subsystems* -Electricity production -Maintenance of the engine -After-treatment of the engine -Handling of production rests -Manufacturing of vehicles and other equipment -Heating of buildings serving the transportation system -Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1994-01-01 - 1997-01-01
Data Type	Random samples
Represents	NTM
Method	The electricity consumption is based on measurements on 6000 freight trains in regular traffic conducted between 1994 and 1997 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The electricity consumption per tonkm was calculated using an load factor of 46%. The *quantity value* refers to an average of the energy use of the studied trains. The *minimum and maximum value* refers to the minimum and the maximum value obtained by the measurements. Current and voltage were measured in the trains tractive units (locomotive or motor coach), at the energy input close to the current collector. Additions were then made for losses in the railways supply system. The results thus obtained give electrical energy consumption per gross-tonne-km reckoned in power outtake from the national grid. The energy use was calculated per net-tonne-km as a function of the trains capacity and load factor. The losses in the railway supply system include losses in converters and catenary cables (efficiency 81,8% for supply to RC locomotives) and losses suffered in transmitting electricity from the power station to the feed-in point (the losses are assumed to be approx. 4 %) For further details see Andersson. The load factor that was used in the calculations is a representative mean value for different types of freight traffic, based on statistics from the State Railways Freight Transportation Division and State Railways Financial department. For the whole of State Railways Freight traffic, excluding iron-ore transport, the mean load factor was about 46% in 1993. (Load factor=net-tonne/gross-tonne where the gross-tonne concept refer to train weight, including locomotive freight wagons and load. The net-tonne concept refers to payload after the weight of the locomotive and wagons have been excluded.)
Literature Reference	Andersson, E., ''Energy consumption and air pollution of electric rail traffic, The Swedish case'', TRITA-FKT, Report 9446, Railway Technlogy, Department of Vehicle Engineering, Royal Institute of Technology, 1994.
Notes	The minimum and maximum value is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Electricity	0.15	0.072	0.27	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997

	-- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Ingela Melkersson, SJ Stab Information, contact person for rail transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Trouve, Johan - SJ (Swedish State Railways), Stab Information, Box 1522, 401 50 Göteborg.
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information on how the goods are handled and the transport is carried out. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used: *Electrically driven freight trains* transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. *Electrically driven combi train* consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transportation by combi train is about 5 % of the total transportation by electrically driven goods trains. *Electrically driven system trains* are not recoupled on the way and always take the same route between two addresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is 50% or higher. System trains ordinarily runs special transportation assignments for different types of industry. *Diesel driven engines* (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the Swedish railway system that are not electrified. SJ also uses a smaller diesel driven engine (V5) for shunting. The V5 engine has a capacity of 450-500 tonnes gross weight and is not ordinarily used for regular traffic. ***Marshalling*** The major part of the goods is marshalled at 6 main junctions were the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (vallväxling) -Fly shunting (planväxling) ***Distance*** The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ (Swedish State Railways) has

	developed environmental data software with a database of distances between 70 different places, considering the infrastructure. The database does however not give information on which lines that are not electrified. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***International train traffic*** The data for the energy use may be used for train transports in Europe, since the technique in other countries are similar (electrically and diesel driven engines). The handling of the goods may however differ in different countries, e.g. regarding average utilisation level etc. Also, the electricity production in different countries varies.
About Data	***Electricity consumption*** The electricity consumption was obtained by energy studies of 6000 trains in regular traffic, including losses in the railway supply system. Several parameters thus influence the energy use, such as e.g. topography, driving technique, the number of starts and stops, number of passing, the trains composition of trucks regarding aerodynamics and the weight of the train etc. The electricity consumption is roughly proportional to the weight of the train. Consequently, the electricity consumption per tonkm for a given utilisation level is approximately constant, independent on the size of the train. ***Utilisation level*** For electrically driven goods trains, the data is based on an average utilisation level of 46 % (including transportation of empty trucks). The average utilisation level was based on statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively. The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation. ***Emissions from electricity production*** When using the data, the electricity production should be included, especially when comparing different modes of transportation. SJ and NGM propose that the following data for average Swedish electricity production should be used to calculate the emissions from electricity production: -NOx: 0,038 g/kWh produced electricity -S: 0,021 g/kWh produced electricity -CO: 0,023 g/kWh produced electricity -HC: 0,0003 g/kWh produced electricity -CO2: 20,8 g/kWh produced electricity The data was given by Vattenfall AB and concern the Swedish electricity production in 1993. The following production methods were used: Hydro-electric power (52%), Nuclear power (42%), Wind power (0,04%), Thermal power (6%) where 2% is fuelled by fossil fuels. Today, SJ buys electricity from Vattenfall and Tälje energi.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Electrically driven Intermodal train, RC engine

Administrative

Finished	Y
Date Completed	99 - 11 -
Copyright	NTM
Availability	The data is publically available.

Technical System

Name	Electrically driven Intermodal train, RC engine
Functional Unit	1 tonkm 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a combi train with an RC engine. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck. The operation includes: -Propulsion (including auxiliary machinery and safety systems) -Comfort during the journey -Complimentary runs -Stationary vehicle heating -Operation of fixed installations (not including heating of premises) Maximum gross weight of the train: 1500 tonnes. Maximum loading capacity with regard to weight: 1031 tonnes.

System Boundaries

Nature Boundary	-Emissions to air have not been included. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1999.
Geographical Boundary	The data is based on Swedish conditions
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. Parameters not considered -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc -Use of lubricating oil -Wear of brake lining, rail and wheel, areal line and collector shoe Excluded subsystems -Electricity production -Maintenence of the engine -Aftertreatement of the engine - Handling of production rests - Manufacturing of vehicles and other equipment - Heating of buildings serving the transportation system - Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1999 - 11-
Data Type	Random samples
Represents	NTM

Method	The electricity consumption is based on measurements on 6000 freight trains in regular traffic conducted between 1994 and 1998 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The electricity consumption per tonkm was calculated using an load factor of 46%. The *quantity value* refers to an average of the energy use of the studied trains. The *minimum and maximum value* refers to the minimum and the maximum value obtained by the measurements. Current and voltage were measured in the trains tractive units (locomotive or motor coach), at the energy input close to the current collector. Additions were then made for losses in the railways supply system. The results thus obtained give electrical energy consumption per gross-tonne-km reckoned in power outtake from the national grid. The energy use was calculated per net-tonne-km as a function of the trains capacity and load factor. The losses in the railway supply system include losses in converters and catenary cables (efficiency 81,8% for supply to RC locomotives) and losses suffered in transmitting electricity from the power station to the feed-in point (the losses are assumed to be approx. 4 %) For further details see Andersson. The load factor that was used in the calculations is a representative mean value for different types of freight traffic, based on statistics from the State Railways Freight Transportation Division and State Railways Financial department. For the whole of State Railways Freight traffic, excluding iron-ore transport, the mean load factor was about 46% in 1993. (Load factor=net-tonne/gross-tonne where the gross-tonne concept refer to train weight, including locomotive freight wagons and load. The net-tonne concept refers to payload after the weight of the locomotive and wagons have been excluded.)
Literature Reference	Andersson, E., ''Energy consumption and air pollution of electric rail traffic, The Swedish case'', TRITA-FKT, Report 9446, Railway Technlogy, Department of Vehicle Engineering, Royal Institute of Technology, 1994.
Notes	The minimum and maximum value is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Electricity	0.043	0.036	0.047	g	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden

About Inventory

Publication	www.ntm.a.se Data Documented by Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM .

Practitioner	Strömberg, Jonas - SJ Cargo Group, Stockholm .
Reviewer	
Applicability	The data should not be used for detailed studies of transportation activities. More detailed data is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information in these matters. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used. Electrically driven trains transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transported by combi trains are about 5 % of the total amount of goods transported by electrically driven trains. Electyrically driven system trains are not recoupled on the way and always take the same route between two adresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is about 50 % or higher. System trains ordinarily runs special transportation assignments for different types of industry. Diesel driven engines (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the swedish railway system that are not electrified. SJ also uses smaller diesel engines (V5) for shunting. The V5 engine has a capacity of 400-500 tonnes gross weight and is not used for regular traffic. -- Marshalling -- The major part of the goods is marshalled at 6 main junctions where the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (valväxling) -Fly shunting (planväxling) -- Distance -- The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ has developed an environmentl data software with a databas of distances between 70 different places, concidering the infrastructure. The database does however not give information on which lines that arenot electrified. -- Bulky goods -- The data can be used for bulcy goods with the recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. -- Emissions from electricity production -- When using the data, the electricity production should be included, especially when comparing different modes of transportation. The emissions from electricity production can be calculated from the mix of electricity production processes that the electricity supplyers have that supplies SJ with electricity. SJ buys exclusivally ''ecolabelled'' electricity, i.e. hydro power with the following emission data (Brännström-Norberg et al., 1996): CO_2: 0,0677 (g/kWh electr.) NO_x: 0,000263 SO_2: 0,000109 CO: 0,0018 Particl.: 0,0000295 HC: 0,000247 NTM has agreed on this way of calculating if the supplyer and buyer have a contract. References: Brännström-Norberg B-M et al (1996). ''Livscykelanalys för Vattenfalls Elproduktion - Sammanfattande rapport'', Vattenfall, Stockholm
About Data	***.Electricity consumption*** The electricity consumption was obtained by energy studies of 6000 trains in regular traffic, including losses in the railway supply system. Several parameters thus influence the energy use, such as e.g. topography, driving technique, the number of starts and stops, number of passing, the trains composition of trucks regarding aerodynamics and the weight of the train etc. The electricity consumption is roughly proportional to the weight of the train. Consequently, the electricity consumption per tonkm for a given utilisation level is approximately constant, independent on the size of the train. ***Utilisation level*** For electrically driven goods trains, the data is based on an average utilisation level of 46 % (including transportation of empty trucks). The average utilisation level was based on

	statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively. The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation.
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by train in NTM. Data is collected from NTM homepage, latest updated 1999 - 11 - 11. The data is continously updated and the user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: www.ntm.a.se The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation.Updated data for diesel trains and road transport are expected to be published before summer 2000. The major Swedish actors in the transportation business, which are members of NTM (e.g., SJ, BTL, ASG, etc.), will use the data as a basis for environmental assessment of different transportation alternatives.

SPINE LCI dataset: Electrically driven intermodal train, RC engine, including electricity production

Administrative	
Finished	Y
Date Completed	99 - 11 -
Copyright	NTM
Availability	The data is publically available.

Technical System	
Name	Electrically driven intermodal train, RC engine, including electricity production
Functional Unit	1 tonkm 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a combi train with an RC engine, including production of electricity used in the transport. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck. The operation includes: -Propulsion (including auxiliary machinery and safety systems) -Comfort during the journey -Complimentary runs -Stationary vehicle heating -Operation of fixed installations (not including heating of premises) Maximum gross weight of the train: 1500 tonnes. Maximum loading capacity with regard to weight: 1031 tonnes. The production of electricity includes fuel production, operation and maintenance of hydro power. SJ buys exclusively ''ecolabelled'' electricity, i.e. hydro power.

System Boundaries

Nature Boundary	Regulated emissions to air are included. Yhe parameters that are presented are: - Regulated emissions for diesel engines: NOx, HC, particles and CO - Fuel regulated: SO2 - Tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1999.
Geographical Boundary	The data is based on Swedish conditions
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. Parameters not considered -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc -Use of lubricating oil -Wear of brake lining, rail and wheel, areal line and collector shoe Excluded subsystems -Maintenence of the engine -Aftertreatement of the engine - Handling of production rests - Manufacturing of vehicles and other equipment - Heating of buildings serving the transportation system - Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1999 - 11-
Data Type	Random samples
Represents	NTM
Method	The electricity consumption is based on measurements on 6000 freight trains in regular traffic conducted between 1994 and 1998 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The electricity consumption per tonkm was calculated using an load factor of 46%. The *quantity value* refers to an average of the energy use of the studied trains. The *minimum and maximum value* refers to the minimum and the maximum value obtained by the measurements. Current and voltage were measured in the trains tractive units (locomotive or motor coach), at the energy input close to the current collector. Additions were then made for losses in the railways supply system. The results thus obtained give electrical energy consumption per gross-tonne-km reckoned in power outtake from the national grid. The energy use was calculated per net-tonne-km as a function of the trains capacity and load factor. The losses in the railway supply system include losses in converters and catenary cables (efficiency 81,8% for supply to RC locomotives) and losses suffered in transmitting electricity from the power station to the feed-in point (the losses are assumed to be approx. 4 %) For further details see Andersson. The load factor that was used in the calculations is a representative mean value for different types of freight traffic, based on statistics from the State Railways Freight Transportation Division and State Railways Financial department. For the whole of State Railways Freight traffic, excluding iron-ore transport, the mean load factor was about 46% in 1993. (Load factor=net-tonne/gross-tonne where the gross-tonne concept refer to train weight, including locomotive freight wagons and load. The net-tonne concept refers to payload after the weight of the locomotive and wagons have been excluded.) ***Emissions from electricity production*** The emissions from electricity production are calculated after the mix of electricity production processes that the electricity supplyers have that supplies SJ with electricity. SJ buys exclusivally ''ecolabelled'' electricity, i.e. hydro power. The with the following emission factors have been used (Brännström-Norberg et al., 1996): CO2: 0,0677 (g/kWh electr.) NOx: 0,000263 SO2: 0,000109 CO: 0,0018 Particl.: 0,0000295 HC: 0,000247 NTM has agreed on this way of calculating if the supplyer and buyer have a contract.
Literature Reference	Brännström-Norberg B-M., et al, Livscykelanalys för Vattenfalls elproduktion Sammanfattande rapport, Vattenfall, 1996. Buhre M., Eriksson Å., Livscykelanalys för kolkraft, Linköping Institute of Technology and Uppsala University, 1997 Andersson, E., ''Energy consumption and air pollution of electric rail traffic, The Swedish case'', TRITA-FKT, Report 9446, Railway Technlogy, Department of Vehicle Engineering, Royal Institute of Technology, 1994.
Notes	The minimum and maximum valuein electricity consumption is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Electricity	0.043	0.036	0.047	g	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.00008			g	Air	Sweden
	Output	Emission	CO2	0.003			g	Air	Sweden
	Output	Emission	HC	0.00001			g	Air	Sweden
	Output	Emission	NOx	0.00001			g	Air	Sweden
	Output	Emission	Particles	0.000001			g	Air	Sweden
	Output	Emission	SO2	0.000005			g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data Documented by Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM .
Practitioner	Strömberg, Jonas - SJ Cargo Group, Stockholm .
Reviewer	
Applicability	The data should not be used for detailed studies of transportation activities. More detailed data is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information in these matters. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used. Electrically driven trains transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transported by combi trains are about 5 % of the total amount of goods transported by electrically driven trains. Electyrically driven system trains are not recoupled on the way and always take the same route between two adresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip,

	i.e. the utilisation level is about 50 % or higher. System trains ordinarily runs special transportation assignments for different types of industry. Diesel driven engines (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the swedish railway system that are not electrified. SJ also uses smaller diesel engines (V5) for shunting. The V5 engine has a capacity of 400-500 tonnes gross weight and is not used for regular traffic. -- Marshalling -- The major part of the goods is marshalled at 6 main junctions where the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (valväxling) -Fly shunting (planväxling) -- Distance -- The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ has developed an environmentl data software with a databas of distances between 70 different places, concidering the infrastructure. The database does however not give information on which lines that arenot electrified. -- Bulky goods -- The data can be used for bulcy goods with the recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.
About Data	.***Electricity consumption*** The electricity consumption was obtained by energy studies of 6000 trains in regular traffic, including losses in the railway supply system. Several parameters thus influence the energy use, such as e.g. topography, driving technique, the number of starts and stops, number of passing, the trains composition of trucks regarding aerodynamics and the weight of the train etc. The electricity consumption is roughly proportional to the weight of the train. Consequently, the electricity consumption per tonkm for a given utilisation level is approximately constant, independent on the size of the train. ***Utilisation level*** For electrically driven goods trains, the data is based on an average utilisation level of 46 % (including transportation of empty trucks). The average utilisation level was based on statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively. The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation. ***Emissions from electricity production*** When using the data, the electricity production should be included, especially when comparing different modes of transportation. The emissions from electricity production are calculated after the mix of electricity production processes that the electricity supplyers have that supplies SJ with electricity. SJ buys exclusivally ''ecolabelled'' electricity, i.e. hydro power with the following emission data (Brännström-Norberg et al., 1996): CO2: 0,0677 (g/kWh electr.) NOx: 0,000263 SO2: 0,000109 CO: 0,0018 Particl.: 0,0000295 HC: 0,000247 NTM has agreed on this way of calculating if the supplyer and buyer have a contract.
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by train in NTM. Data is collected from NTM homepage, latest updated 1999 - 11 - 11. The data is continously updated and the user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: www.ntm.a.se The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation.Updated data for diesel trains and road transport are expected to be published before summer 2000. The major Swedish actors in the transportation business, which are members of NTM (e.g., SJ, BTL, ASG, etc.), will use the data as a basis for environmental assessment of different transportation alternatives.

SPINE LCI dataset: Electrically driven system train (Circuit-working), RC engine

Administrative	
Finished	Y
Date Completed	99 - 11 -
Copyright	NTM
Availability	The data is publically available.

Technical System	
Name	Electrically driven system train (Circuit-working), RC engine
Functional Unit	1 tonkm, 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of an electrically driven system train, driven by an RC engine. Electrically driven system trains are not recoupled on the way and always take the same route between two addresses. No marshalling is done, but a diesel engine may be used at the end points. System trains ordinarily runs special transportation assignments for different types of industry The operation includes -Propulsion (including auxiliary machinery and safety systems) -Comfort during the journey -Complimentary runs -Stationary vehicle heating -Operation of fixed installations (not including heating of premises) Maximum gross weight of the train: 1500 tonnes. Maximum loading capacity with regard to weight: 1031 tonnes.

System Boundaries	
Nature Boundary	-Emissions to air have not been included. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1999
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc. -Use of lubricating oil -Wear of brake lining, rail and wheel, aerial line and collector shoe *Excluded subsystems* -Electricity production -Maintenance of the engine -After-treatment of the engine -Handling of production rests -Manufacturing of vehicles and other equipment -Heating of buildings serving the transportation system -Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1999 - 11
Data Type	Random samples
Represents	NTM
Method	The electricity consumption is based on measurements on 6000 freight trains in regular traffic conducted between 1994 and 1997 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The electricity consumption per tonkm was calculated using an load factor of 46%. The *quantity value* refers to an average of the energy use of the studied trains. The *minimum and maximum value* refers to the minimum and the maximum value obtained by the measurements. Current and voltage were measured in the trains tractive units (locomotive or motor coach), at the energy input close to the current collector. Additions were then made for losses in the railways supply system. The results thus obtained give electrical energy consumption per gross-tonne-km reckoned in power outtake from the national grid. The energy use was calculated per net-tonne-km as a function of the trains capacity and load factor. The losses in the railway supply system include losses in converters and catenary cables (efficiency 81,8% for supply to RC locomotives) and losses suffered in transmitting electricity from the power station to the feed-in point (the losses are assumed to be approx. 4 %) For further details see Andersson. The load factor that was used in the calculations is a representative mean value for different types of freight traffic, based on statistics from the State Railways Freight Transportation Division and State Railways Financial department. For the whole of State Railways Freight traffic, excluding iron-ore transport, the mean load factor was about 46% in 1993. (Load factor=net-tonne/gross-tonne where the gross-tonne concept refer to train weight, including locomotive freight wagons and load. The net-tonne concept refers to payload after the weight of the locomotive and wagons have been excluded.)
Literature Reference	Andersson, E., ''Energy consumption and air pollution of electric rail traffic, The Swedish case'', TRITA-FKT, Report 9446, Railway Technlogy, Department of Vehicle Engineering, Royal Institute of Technology, 1994.
Notes	The minimum and maximum value is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Electricity	0.05	0.027	0.072	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden

About Inventory

Publication	www.ntm.a.se Data Documented by Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Data documented by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation)

	The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Strömberg, Jonas - SJ Cargo Group, Stockholm .
Reviewer	
Applicability	The data should not be used for detailed studies of transportation activities. More detailed data is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information in these matters. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used. Electrically driven trains transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transported by combi trains are about 5 % of the total amount of goods transported by electrically driven trains. Electyrically driven system trains are not recoupled on the way and always take the same route between two adresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is about 50 % or higher. System trains ordinarily runs special transportation assignments for different types of industry. Diesel driven engines (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the swedish railway system that are not electrified. SJ also uses smaller diesel engines (V5) for shunting. The V5 engine has a capacity of 400-500 tonnes gross weight and is not used for regular traffic. -- Marshalling -- The major part of the goods is marshalled at 6 main junctions where the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (valväxling) -Fly shunting (planväxling) -- Distance -- The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ has developed an environmentl data software with a databas of distances between 70 different places, concidering the infrastructure. The database does however not give information on which lines that arenot electrified. -- Bulky goods -- The data can be used for bulcy goods with the recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. -- Emissions from electricity production -- When using the data, the electricity production should be included, especially when comparing different modes of transportation. The emissions from electricity production can be calculated from the mix of electricity production processes that the electricity supplyers have that supplies SJ with electricity. SJ buys exclusivally ''ecolabelled'' electricity, i.e. hydro power with the following emission data (Brännström-Norberg et al., 1996): CO2: 0,0677 (g/kWh electr.) NOx: 0,000263 SO2: 0,000109 CO: 0,0018 Particl.: 0,0000295 HC: 0,000247 NTM has agreed on this way of calculating if the supplyer and buyer have a contract. References: Brännström-Norberg B-M et al (1996). ''Livscykelanalys för Vattenfalls Elproduktion - Sammanfattande rapport'', Vattenfall, Stockholm
About Data	***Electricity consumption*** The electricity consumption was obtained by energy studies of 6000 trains in regular traffic, including losses in the railway supply system. Several parameters thus influence the energy use, such as e.g. topography, driving technique, the number of starts and stops, number of

	passing, the trains composition of trucks regarding aerodynamics and the weight of the train etc. The electricity consumption is roughly proportional to the weight of the train. Consequently, the electricity consumption per tonkm for a given utilisation level is approximately constant, independent on the size of the train. ***Utilisation level*** For electrically driven goods trains, the data is based on an average utilisation level of 46 % (including transportation of empty trucks). The average utilisation level was based on statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively. The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation.
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by train in NTM. Data is collected from NTM homepage, latest updated 1999 - 11 - 11. The data is continously updated and the user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: www.ntm.a.se The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation.Updated data for diesel trains and road transport are expected to be published before summer 2000. The major Swedish actors in the transportation business, which are members of NTM (e.g., SJ, BTL, ASG, etc.), will use the data as a basis for environmental assessment of different transportation alternatives.

SPINE LCI dataset: Electrically driven system train (Circuit-working), RC engine, including electricity production

Administrative	
Finished	Y
Date Completed	99 - 11 -
Copyright	NTM
Availability	The data is publically available.

Technical System	
Name	Electrically driven system train (Circuit-working), RC engine, including electricity production
Functional Unit	1 tonkm, 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of an electrically driven system train, driven by an RC engine, including production of electricity used in the transport. Electrically driven system trains are not recoupled on the way and always take the same route between two addresses. No marshalling is done, but a diesel engine may be used at the end points. System trains ordinarily runs special transportation assignments for different types of industry The operation includes -Propulsion (including auxiliary machinery and safety systems) -Comfort during the journey -Complimentary runs -Stationary vehicle heating -Operation of fixed installations (not including heating of premises)

	Maximum gross weight of the train: 1500 tonnes. Maximum loading capacity with regard to weight: 1031 tonnes. The production of electricity includes fuel production, operation and maintenance of hydro power. SJ buys exclusively ''ecolabelled'' electricity, i.e. hydro power.

System Boundaries

Nature Boundary	Regulated emissions to air are included. Yhe parameters that are presented are: - Regulated emissions for diesel engines: NOx, HC, particles and CO - Fuel regulated: SO2 - Tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1999
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc. -Use of lubricating oil -Wear of brake lining, rail and wheel, aerial line and collector shoe *Excluded subsystems* -Maintenance of the engine -After-treatment of the engine -Handling of production rests -Manufacturing of vehicles and other equipment -Heating of buildings serving the transportation system -Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1999 - 11
Data Type	Random samples
Represents	NTM
Method	The electricity consumption is based on measurements on 6000 freight trains in regular traffic conducted between 1994 and 1997 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The electricity consumption per tonkm was calculated using an load factor of 46%. The *quantity value* refers to an average of the energy use of the studied trains. The *minimum and maximum value* refers to the minimum and the maximum value obtained by the measurements. Current and voltage were measured in the trains tractive units (locomotive or motor coach), at the energy input close to the current collector. Additions were then made for losses in the railways supply system. The results thus obtained give electrical energy consumption per gross-tonne-km reckoned in power outtake from the national grid. The energy use was calculated per net-tonne-km as a function of the trains capacity and load factor. The losses in the railway supply system include losses in converters and catenary cables (efficiency 81,8% for supply to RC locomotives) and losses suffered in transmitting electricity from the power station to the feed-in point (the losses are assumed to be approx. 4 %) For further details see Andersson. The load factor that was used in the calculations is a representative mean value for different types of freight traffic, based on statistics from the State Railways Freight Transportation Division and State Railways Financial department. For the whole of State Railways Freight traffic, excluding iron-ore transport, the mean load factor was about 46% in 1993. (Load factor=net-tonne/gross-tonne where the gross-tonne concept refer to train weight, including locomotive freight wagons and load. The net-tonne concept refers to payload after the weight of the locomotive and wagons have been excluded.) ***Emissions from electricity production*** The emissions from electricity production are calculated after the mix of electricity production processes that the electricity supplyers have that supplies SJ with electricity. SJ buys exclusivally ''ecolabelled'' electricity, i.e. hydro power. The with the following emission factors have been used (Brännström-Norberg et al., 1996): CO2: 0,0677 (g/kWh electr.) NOx: 0,000263 SO2: 0,000109 CO: 0,0018 Particl.: 0,0000295 HC: 0,000247 NTM has agreed on this way of calculating if the supplier and buyer have a contract.

Literature Reference	Andersson, E., ''Energy consumption and air pollution of electric rail traffic, The Swedish case'', TRITA-FKT, Report 9446, Railway Technlogy, Department of Vehicle Engineering, Royal Institute of Technology, 1994. Brännström-Norberg B-M., et al, Livscykelanalys för Vattenfalls elproduktion Sammanfattande rapport, Vattenfall, 1996.
Notes	The minimum and maximum value in electricity consumption is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Electricity	0.05	0.027	0.072	kWh	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	0.00009			g	Air	
	Output	Emission	CO2	0.04			g	Air	
	Output	Emission	HC	0.00001			g	Air	
	Output	Emission	NOx	0.00001			g	Air	
	Output	Emission	Particles	0.000001			g	Air	
	Output	Emission	SO2	0.000006			g	Air	

About Inventory

Publication	www.ntm.a.se Data Documented by Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Strömberg, Jonas - SJ Cargo Group, Stockholm .
Reviewer	
Applicability	The data should not be used for detailed studies of transportation activities. More detailed data is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information in these matters. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used. Electrically driven trains transport 95 % of the goods handled by train. Each truck of the

	trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. Electrically driven combi train consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transported by combi trains are about 5 % of the total amount of goods transported by electrically driven trains. Electyrically driven system trains are not recoupled on the way and always take the same route between two adresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is about 50 % or higher. System trains ordinarily runs special transportation assignments for different types of industry. Diesel driven engines (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the swedish railway system that are not electrified. SJ also uses smaller diesel engines (V5) for shunting. The V5 engine has a capacity of 400-500 tonnes gross weight and is not used for regular traffic. -- Marshalling -- The major part of the goods is marshalled at 6 main junctions where the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (valväxling) -Fly shunting (planväxling) -- Distance -- The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ has developed an environmentl data software with a databas of distances between 70 different places, concidering the infrastructure. The database does however not give information on which lines that arenot electrified. -- Bulky goods -- The data can be used for bulcy goods with the recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.
About Data	***Electricity consumption*** The electricity consumption was obtained by energy studies of 6000 trains in regular traffic, including losses in the railway supply system. Several parameters thus influence the energy use, such as e.g. topography, driving technique, the number of starts and stops, number of passing, the trains composition of trucks regarding aerodynamics and the weight of the train etc. The electricity consumption is roughly proportional to the weight of the train. Consequently, the electricity consumption per tonkm for a given utilisation level is approximately constant, independent on the size of the train. ***Utilisation level*** For electrically driven goods trains, the data is based on an average utilisation level of 46 % (including transportation of empty trucks). The average utilisation level was based on statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively. The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation. ***Emissions from electricity production*** When using the data, the electricity production should be included, especially when comparing different modes of transportation. The emissions from electricity production are calculated after the mix of electricity production processes that the electricity supplyers have that supplies SJ with electricity. SJ buys exclusivally ''ecolabelled'' electricity, i.e. hydro power with the following emission data (Brännström-Norberg et al., 1996): CO2: 0,0677 (g/kWh electr.) NOx: 0,000263 SO2: 0,000109 CO: 0,0018 Particl.: 0,0000295 HC: 0,000247 NTM has agreed on this way of calculating if the supplyer and buyer have a contract.
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by train in NTM. Data is collected from NTM homepage, latest updated 1999 - 11 - 11. The data is continously updated and the user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: www.ntm.a.se The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation.Updated data for diesel trains and road transport are expected to be published before summer 2000.

	The major Swedish actors in the transportation business, which are members of NTM (e.g., SJ, BTL, ASG, etc.), will use the data as a basis for environmental assessment of different transportation alternatives.

SPINE LCI dataset: Electrically driven system train, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Electrically driven system train, future
Functional Unit	1 tonkm, 46 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of an electrically driven system train, assuming different energy saving measures in the existing system (e.g. rebuilding trains etc.) The aim is to get a picture of future energy use of electric train traffic. Electrically driven system trains are not recoupled on the way and always take the same route between two addresses. No marshalling is done, but a diesel engine may be used at the end points.

System Boundaries	
Nature Boundary	Diffuse emissions to air and emissions to water and ground, noise, encroachment and other environmental impacts have not been considered.
Time Boundary	The data represents an assessment of future energy use and emissions of electric train traffic.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc. -Use of lubricating oil -Wear of brake lining, rail and wheel, aerial line and collector shoe *Excluded subsystems* -Electricity production -Maintenance of the engine -After-treatment of the engine -Handling of production rests -Manufacturing of vehicles and other equipment -Heating of buildings serving the transportation system -Erection and maintenance of infrastructure

Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The electricity consumption was calculated using the assumption that the energy use may be reduced by 35 % by new engines and rebuilding existing engines together with data for existing trains in regular traffic with the lowest energy use. The assumption was based on Andersson. The electricity consumption per tonkm was calculated using an load factor of 46%. The data for trains in use in regular traffic today can be found in the activity ObjectOfStudy.Name: Electrically driven goods train 700 metres, RC engine (in this database)or in NGM. The minimum value for the energy use was used in the calculation. The data is based on measurements on freight trains in regular traffic conducted between 1994 and 1997 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The data includes losses in the railway supply system.
Literature Reference	Andersson, E., 'Future Energy Consumption of the Railways' (in Swedish), TRITA-FKT 1996:49, Railway Technology, Department of Vehicle Engineering, Royal Institute of Technology, 1994. NGM (Nätverket för Godstransporter och Miljön) Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997, NGM, (In Swedish) 1997
Notes	The minimum and maximum value in electricity consumption is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Electricity	0.072			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Ingela Melkersson, SJ Stab Information, contact person for rail transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and

	emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Trouve, Johan - SJ (Swedish State Railways), Stab Information, Box 1522, 401 50 Göteborg.
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions for Swedish train traffic. The data represents new technology not yet in use.
About Data	***Electricity consumption*** The electricity consumption was based on assumptions that the energy use in the existing system may be reduced by 35% by different energy saving measures, rebuilding existing engines and new engines. ***Emissions from electricity production*** When using the data, the electricity production should be included, especially when comparing different modes of transportation. SJ and NGM propose that the following data for average Swedish electricity production should be used to calculate the emissions from electricity production: -NOx: 0,038 g/kWh produced electricity -S: 0,021 g/kWh produced electricity -CO: 0,023 g/kWh produced electricity -HC: 0,0003 g/kWh produced electricity -CO2: 20,8 g/kWh produced electricity The data was given by Vattenfall AB and concern the Swedish electricity production in 1993. The following production methods were used: Hydro-electric power (52%), Nuclear power (42%), Wind power (0,04%), Thermal power (6%) where 2% is fuelled by fossil fuels. Today, SJ buys electricity from Vattenfall and Tälje energi
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Electrically driven system train, RC engine

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Electrically driven system train, RC engine
Functional Unit	1 tonkm, 46 %

Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 46 %. An utilisation level of 46 % is representative for Swedish domestic traffic if *transportation of empty trucks are included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of an electrically driven system train, driven by an RC engine. Electrically driven system trains are not recoupled on the way and always take the same route between two addresses. No marshalling is done, but a diesel engine may be used at the end points. System trains ordinarily runs special transportation assignments for different types of industry The operation includes -Propulsion (including auxiliary machinery and safety systems) -Comfort during the journey -Complimentary runs -Stationary vehicle heating -Operation of fixed installations (not including heating of premises) Maximum gross weight of the train: 1500 tonnes. Maximum loading capacity with regard to weight: 1031 tonnes.

System Boundaries

Nature Boundary	Diffuse emissions to air and emissions to water and ground, noise, encroachment and other environmental impacts have not been considered.
Time Boundary	The data represents the fleet in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 46 %. The utilisation level includes transportation of empty trucks. *Parameters not considered* -Driving technique -Maintenance level of the engine -External conditions i.e. climate etc. -Use of lubricating oil -Wear of brake lining, rail and wheel, aerial line and collector shoe *Excluded subsystems* -Electricity production -Maintenance of the engine -After-treatment of the engine -Handling of production rests -Manufacturing of vehicles and other equipment -Heating of buildings serving the transportation system -Erection and maintenance of infrastructure
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1994-01-01 - 1997-01-01
Data Type	Random samples
Represents	NTM
Method	The electricity consumption is based on measurements on 6000 freight trains in regular traffic conducted between 1994 and 1997 by the Department of Vehicle Engineering, Railway Technology, Royal Institute of Technology (KTH). The electricity consumption per tonkm was calculated using an load factor of 46%. The *quantity value* refers to an average of the energy use of the studied trains. The *minimum and maximum value* refers to the minimum and the maximum value obtained by the measurements. Current and voltage were measured in the trains tractive units (locomotive or motor coach), at the energy input close to the current collector. Additions were then made for losses in the railways supply system. The results thus obtained give electrical energy consumption per gross-tonne-km reckoned in power outtake from the national grid. The energy use was calculated per net-tonne-km as a function of the trains capacity and load factor. The losses in the railway supply system include losses in converters and catenary cables (efficiency 81,8% for supply

	to RC locomotives) and losses suffered in transmitting electricity from the power station to the feed-in point (the losses are assumed to be approx. 4 %) For further details see Andersson. The load factor that was used in the calculations is a representative mean value for different types of freight traffic, based on statistics from the State Railways Freight Transportation Division and State Railways Financial department. For the whole of State Railways Freight traffic, excluding iron-ore transport, the mean load factor was about 46% in 1993. (Load factor=net-tonne/gross-tonne where the gross-tonne concept refer to train weight, including locomotive freight wagons and load. The net-tonne concept refers to payload after the weight of the locomotive and wagons have been excluded.)
Literature Reference	Andersson, E., ''Energy consumption and air pollution of electric rail traffic, The Swedish case'', TRITA-FKT, Report 9446, Railway Technlogy, Department of Vehicle Engineering, Royal Institute of Technology, 1994.
Notes	The minimum and maximum value is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Electricity	0.18	0.097	0.26	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Ingela Melkersson, SJ Stab Information, contact person for rail transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Trouve, Johan - SJ (Swedish State Railways), Stab Information, Box 1522, 401 50 Göteborg.
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to obtain information on how the goods are handled and the transport is carried out. Railway traffic generally handles transportation of large heavy goods over long distances. Both electrically driven and diesel driven trains may be used:

	Electrically driven freight trains transport 95 % of the goods handled by train. Each truck of the trains may be assumed to have a loading capacity with regard to weight of 55 tonnes and a maximum gross weight of 80 tonnes. The trains are normally marshalled. *Electrically driven combi train* consists of trucks loaded with load carriers that also may be loaded and transported by truck. The share of goods transportation by combi train is about 5 % of the total transportation by electrically driven goods trains. *Electrically driven system trains* are not recoupled on the way and always take the same route between two addresses. No marshalling is done, but a diesel engine may be used at the end points. The trains are generally fully loaded one way, and empty on the return trip, i.e. the utilisation level is 50% or higher. System trains ordinarily runs special transportation assignments for different types of industry. *Diesel driven engines* (T44) are mainly used for shunting and for regular traffic in sections where there is no aerial line. There are still some sections of the Swedish railway system that are not electrified. SJ also uses a smaller diesel driven engine (V5) for shunting. The V5 engine has a capacity of 450-500 tonnes gross weight and is not ordinarily used for regular traffic. ***Marshalling*** The major part of the goods is marshalled at 6 main junctions were the goods are gathered and new trains are put together for new destinations. Shunting is generally done by diesel driven engines and is performed in two ways: -Hump shunting (vallväxling) -Fly shunting (planväxling) ***Distance*** The railway network and the fact that the goods generally are marshalled means that the goods not always travel the shortest route between two destinations. When using the data, the distance may thus be difficult to assess. The company carrying out the transport should be contacted to get an accurate estimate of the distance. SJ (Swedish State Railways) has developed environmental data software with a database of distances between 70 different places, considering the infrastructure. The database does however not give information on which lines that are not electrified. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume of the goods to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***International train traffic*** The data for the energy use may be used for train transports in Europe, since the technique in other countries are similar (electrically and diesel driven engines). The handling of the goods may however differ in different countries, e.g. regarding average utilisation level etc. Also, the electricity production in different countries varies.
About Data	***Electricity consumption*** The electricity consumption was obtained by energy studies of 6000 trains in regular traffic, including losses in the railway supply system. Several parameters thus influence the energy use, such as e.g. topography, driving technique, the number of starts and stops, number of passing, the trains composition of trucks regarding aerodynamics and the weight of the train etc. The electricity consumption is roughly proportional to the weight of the train. Consequently, the electricity consumption per tonkm for a given utilisation level is approximately constant, independent on the size of the train. ***Utilisation level*** For electrically driven goods trains, the data is based on an average utilisation level of 46 % (including transportation of empty trucks). The average utilisation level was based on statistics from 1993 from the Swedish State Railways. Today the average utilisation level is higher according to the Swedish State Railways due to different actions to use the trains more effectively. The utilisation level for a specific transport may vary. There are however no general rules regarding differences in the utilisation level, and what utilisation level to chose for a specific transport operation. ***Emissions from electricity production*** When using the data, the electricity production should be included, especially when comparing different modes of transportation. SJ and NGM propose that the following data for average Swedish electricity production should be used to calculate the emissions from electricity production: -NOx: 0,038 g/kWh produced electricity -S: 0,021 g/kWh produced electricity -CO: 0,023 g/kWh produced electricity -HC: 0,0003 g/kWh produced electricity -CO2: 20,8 g/kWh produced electricity The data was given by Vattenfall AB and concern the Swedish electricity production in 1993. The following production methods were used: Hydro-electric power (52%), Nuclear power (42%), Wind power (0,04%), Thermal power (6%) where 2% is fuelled by fossil fuels. Today, SJ buys electricity from Vattenfall and Tälje energi.

Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Electricity production and distribution - India - Regionalized

Administrative	
Finished	Y
Date Completed	2016-12-12
Copyright	
Availability	Public

Technical System	
Name	Electricity production and distribution - India - Regionalized
Functional Unit	1 kWh
Functional Unit Explanation	Electricity delivered to consumer.
Process Type	Gate to gate
Site	
Sector	Energyware
Owner	
Technical system description	This is a compliation of regionalized LCI datasets for electricity production and distribution in India. The technical boundary starts at the constructed power plant ready to produce electricity (excluded: fuel extraction, processing, and transportation to the power plant) and ends at the power distribution grid where electricity is available for consumption. The activities contain domestic production, import from neighbouring grids (including Bhutan), transmission and transformation infrastructure, associated emissions, and losses during transmission according to ecoinvent methodology. Electricity production datasets per Indian states/unions and territories: Lignite Hard coal Oil Natural gas Nuclear Wind Solar Import of electricity from Bhutan. Production mix and transformation and distribution per Indian regional grids. For detailed information please see Hossain M N, 2016, "Regionalized Life Cycle Inventory of

	Power Producing Technologies and Power Grids in India", master thesis report, Industrial Ecology programme, Chalmers University of Technology, Dept. Energy and Envrionment, Div. of Environmental Systems Analysis, ESA report 2016:15 The LCI data are available in Excel spreadsheets here: Hossain_2016_Electricity_production_and_distribution_India_regionalized.zip User Guide to the excel files The datasets on electrcity production from different sources across Indian States/Union Territory, and Transformartion and Transmission of electricity via regional grids. The excel files show the the specific parameter data we have collected and specific equations we have used to calculate emissions from electricity producing technologies in India. Each file contains a readme tab which describes the name and content of the other tabs. Specifically, " production_mix_India_MNH documents electricity mix of Indian Geographic Units (i.e. States, Union Territories, Regions). " import_India_MNH documents the import from Bhutan. " electricity transformation and transmission losses_India_MNH documents all the electricity losses due to the transformation and transmission among the regional grids. " Other files document dataset on electricity production from different sources (i.e. hard coal, lignite, natural gas, oil, hydro, nuclear, wind, and solar). The datasets are now undergoing the documentation phase to be submitted to the reference LCI database - ecoinvent which will be available in ecospold format.

System Boundaries

Nature Boundary	
Time Boundary	The inventory is prepared as for 2012 because latest and most consistent data was available for the fiscal year 2012-13.
Geographical Boundary	Electricity distribution per 5 regional grids in India. Import of electricity from Buthan. Electricity production from 25 (of 28) states and 4 (of 7) union territories. 3 states (Chandigarh, Daman and Diu, and Dadar & Nagar Haveli) and 3 union territories (Lakshadweep, Andaman and Nicobar, and Mizoram) out not included due to no or negligleble production capacity and also very small consumption.
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	2016
Data Type	Derived, mixed
Represents	NTM
Method	Derived
Literature Reference	Spread sheets with data: Hossain_2016_Electricity_production_and_distribution_India_regionalized.zip
Notes	The minimum and maximum value is caused by variations in external conditions (number of stops, topography, number of passings, the trains composition of trucks regarding aerodynamics, driving technique and climate)

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Output	Product	Electricity	1			kWh	Technosphere	India

About Inventory

Publication	For detailed information please see Report: Hossain M N, 2016, "Regionalized Life Cycle Inventory of Power Producing Technologies and Power Grids in India", master thesis report, Industrial Ecology programme, Chalmers University of Technology, Dept. Energy and Envrionment, Div. of Environmental Systems Analysis, ESA report 2016:15 Spreadsheets with data: Hossain_2016_Electricity_production_and_distribution_India_Regionalized.zip
Intended User	LCA practitioner
General Purpose	Reference LCI data
Detailed Purpose	Improving LCI data quality of electricity production and distribution in India by increasing geographical resolution from national level
Commissioner	
Practitioner	Muhammed Noor Hossain - .
Reviewer	See About data -
Applicability	
About Data	This LCI data compilation is a result from a Master Thesis project conducted by Muhammed Noor Hossain in 2016 within the Industrial Ecology programme, Chalmers University of Technology, Sweden in collaboration with ecoinvent Centre, Zurich, Switzerland. Thesis supervision was provided from by Johan Tivander and examination by Anne-Marie Tillman at Chalmers. The data published here has been collected, modelled and undergone initial review according to ecoinvent procedures. Methodologcial supervision and data review was provided by Karin Treyer and Tereza Lévová at ecoinvent. The data is pending publication in ecoinvent reference LCI database.
Notes	

SPINE LCI dataset: Electronic Control Unit’s aluminium capacitor manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit’s aluminium capacitor manufacturing. Autoliv ESA-DBP
Functional Unit	1.6 gram of aluminium capacitor
Functional Unit Explanation	Aluminium capacitor is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A capacitor is an electronic component that stores energy in the form of an electric field. It can also be used as a filter of signals with different frequencies. It is made of conductors separated with an insulator or dialectric. There are many types of capacitors for example: electrolytic (aluminium or tantalum), ceramic and many others In an electronic control unit 4 different types of capacitors are placed; aluminium, cradle, tantalum and ceramic. In the studied aluminium capacitor there are 2 aluminium electrodes

	and paper as an isolator. The rest of the materials has a housing function and to connect into the circuit. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. The detailed steps of the process are unknown. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The capacitor aluminium is manufactured in the plant in Malaysia.
Other Boundaries	Excerpt from the report, see 'Publlication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	4.37E-02			m3	Water	Malaysia
	Input	Refined resource	Aluminium foil	7.91E-01			g	Technosphere	Malaysia
	Input	Refined resource	Cellulose paper	1.09E-01			g	Technosphere	Malaysia
	Input	Refined resource	Copper wire	3.88E-03			g	Technosphere	Malaysia
	Input	Refined resource	Electricity	1.48E-01			MJ	Technosphere	Malaysia
	Input	Refined resource	Fe	1.33E-02			g	Technosphere	Malaysia

	Input	Refined resource	gamma-NaOH	2.42E-01			g	Technosphere	Malaysia
	Input	Refined resource	Polybutylene	3.02E-01			g	Technosphere	Malaysia
	Input	Refined resource	Polyethylene terephthalate (PET)	1.81E-02			g	Technosphere	Malaysia
	Input	Refined resource	PPA-PPS	1.21E-01			g	Technosphere	Malaysia
Notes: for tin plating	Input	Refined resource	Sn	8.88E-04			g	Technosphere	Malaysia
	Output	Product	Aluminium capacitor	1.60E+00			g	Technosphere	Malaysia
	Output	Residue	Waste water	4.62E-02			m3	Technosphere	Malaysia

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed aluminium capacitor is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP
Functional Unit	34.4 grams of electronic connector
Functional Unit Explanation	Electronic connector is a part of the electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The studied connector is made of polymer, copper (wire), and tin (for plating). It is mounted on a printed circuit board. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is gate-to-gate. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in India.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Copper wire	2.83E+01			g	Technosphere	India
	Input	Refined resource	Electricity	8.06E-01			MJ	Technosphere	India
	Input	Refined resource	Polymer	2.83E+01			g	Technosphere	India
Notes: for plating	Input	Refined resource	Tin	6.03E-03			g	Technosphere	India
	Output	Product	Connector	3.44E+01			g	Technosphere	India

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed connector is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP
Functional Unit	1 unit of housing
Functional Unit Explanation	1 housing weighs 260 grams and it constitues more than half of the weight of the electronic control unit whose total weight is 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The discussed part has a housing function. It is a base where the whole mechanism of electronic control unit is placed. It is made of aluminium alloy and it weighs 260 grams. It is manufactured in Budapest in Hungary and then transported to Autoliv in Motala, Sweden. The manufacturing process relates basically to the mold casting of housing. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is gate-to-gate. It relates to mold casting which is followed by packing. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Budapest in Hungary.

Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Natural gas	2.88E-07			MJ	Technosphere	Hungary
	Input	Natural resource	Water	2.26E-09			m3	Water	Hungary
	Input	Refined resource	Aluminium alloy	2.60E+02			g	Technosphere	Hungary
	Input	Refined resource	Electricity	1.37E-07			MJ	Technosphere	Hungary
Notes: The product weighs 260 grams.	Output	Product	Housing	1			pce	Technosphere	Hungary
	Output	Residue	Waste water	8.80E-07			m3	Technosphere	Hungary

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed housing is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-

	Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's inductor choke manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit's inductor choke manufacturing. Autoliv ESA-DBP
Functional Unit	3.66 grams of inductor choke
Functional Unit Explanation	1 inductor choke is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	An inductor choke in electrical devices blocks higher frequencies in an electrical circuit and passes signals of lower frequency or direct current. In the electronic control unit it is one of the inductors together with coil, common mode filter and TBD. The role of the inductor is to distinguish the signals sent from the sensors into these wanted and unwanted ones. The choke consists of Zn-Ni ferrite core and a wire which is made of copper. The manufacturing process starts with mounting the core which is followed by winding the wire and fastening it to the core by ultrasonic welding. In the end it is tested and packed before dispatch. It is manufactured in the company which is located in China and then transported to Autoliv Motala in Sweden. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP

	- Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with mounting the core and finishes with testing. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in China.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	5.00E-05			m3	Water	China
	Input	Refined resource	Adhesive (calcium carbonate)	3.49E-02			g	Technosphere	China
	Input	Refined resource	Adhesive (epoxy resin)	2.50E-02			g	Technosphere	China
	Input	Refined resource	Copper wire	1.02E+00			g	Technosphere	China
	Input	Refined resource	Electricity	8.12E-02			MJ	Technosphere	China
Notes: titanium dioxid	Input	Refined resource	Ink	1.00E-04			g	Technosphere	China
	Input	Refined resource	Polyurethane resin	3.15E-02			g	Technosphere	China
	Input	Refined resource	Resin base (silica)	2.54E-01			g	Technosphere	China
Notes: tin plate	Input	Refined resource	Solder	2.00E-02			g	Technosphere	China
	Input	Refined resource	Terminal (copper sheet)	8.00E-02			g	Technosphere	China
	Input	Refined resource	Zn-Ni ferrite core	2.20E+00			g	Technosphere	China
	Output	Product	Inductor choke	3.66E+00			g	Technosphere	China
	Output	Residue	Waste	1.14E+00			g	Technosphere	China
	Output	Residue	Waste water	4.56E-05			g	Technosphere	China

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed inductor choke is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and improves an engine performance but also manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP

Functional Unit	0.11 grams of integrated circuit ASIC
Functional Unit Explanation	Integrated circuit ASIC (application specific integrated circuit) is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	An integrated circuit is a small chip that consists of a small waffer with semiconductor devices such as transistors, resistors and capacitors. It is manufactured in a surface of a thin semiconductor material. The studied product consists of silicon (chip), silver (die attach and die plating), alloy nickel iron (leadframe), gold (wire), silica (encapsulation) and tin. It is produced in Malaysia and transported to Motala, Sweden. The manufacturing process of integrated circuit is presented in the reference report: (excerpt from the report, see 'Publication') ''Regarding the process of manufacturing, wafer mounting and sawing are performed as the first step in the process. Afterwards, Die attach is bounded to the lead frame. Later on, the processes of snap cure, wire bonding, molding, post mode cure, deflashing, plating and cropping are performed in turn. Lastly, manufacturing of integrated circuit is ended up with labeling and packing''. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with wafer mounting and sawing and ends with labelling and packing. During the process waste is produced. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Malaysia.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown

Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Water	2.62E+00			l	Water	Malaysia
Notes: For die plating	Input	Refined resource	Ag	9.46E-04			g	Technosphere	Malaysia
	Input	Refined resource	Chip (silicon)	3.00E-03			g	Technosphere	Malaysia
	Input	Refined resource	Die attach (silver)	2.75E-04			g	Technosphere	Malaysia
	Input	Refined resource	Electricity	1.31E+00			MJ	Technosphere	Malaysia
	Input	Refined resource	Encapsulation (silica)	7.05E-02			g	Technosphere	Malaysia
	Input	Refined resource	Gold wire	1.18E-03			g	Technosphere	Malaysia
Notes: For leadframe	Input	Refined resource	Nickel iron alloy	3.33E-02			g	Technosphere	Malaysia
Notes: Leadfinish	Input	Refined resource	Sn	7.59E-04			g	Technosphere	Malaysia
	Output	Product	Integrated circuit ASIC	1.10E-01			g	Technosphere	Malaysia
	Output	Residue	Waste	5.75E+00			g	Technosphere	Malaysia

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed integrated circuit ASIC is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit’s integrated circuit comparator manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit’s integrated circuit comparator manufacturing. Autoliv ESA-DBP
Functional Unit	0.0147 grams of integrated circuit comparator
Functional Unit Explanation	Integrated circuit comparator is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	An integrated circuit is a small chip that consists of a small waffer with semiconductor devices such as transistors, resistors and capacitors. It is manufactured in a surface of a thin semiconductor material. An integrated circuit comparator is used to compare 2 different voltages or currents and indicates the result as output (Wikipedia 1b, 2010). The studied product consists of silicon (chip), silver (attach and internal lead finish), tin (solder), mold compound (silica), copper (leadframe) and gold (wire). It is produced in Melaka, Malaysia and transported to Motala, Sweden. The manufacturing process of integrated circuit is presented in the reference report: (excerpt from the report, see ’Publication’) ’’Regarding the process of manufacturing, wafer mounting and sawing are performed as the first step in the process. Afterwards, Die attach is bounded to the lead frame. Later on, the processes of snap cure, wire bonding, molding, post mode cure, deflashing, plating and cropping are performed in turn. Lastly, manufacturing of integrated circuit is ended up with labeling and packing’’. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv’s Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit’s label manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit interface manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is gate-to-gate. It starts with wafer mounting and sawing and ends with labelling and packing. During the process hazardous waste is produced. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Melaka, Malaysia.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	4.47E-04			m3	Water	Malaysia
Notes: Internal lead finish	Input	Refined resource	Ag	5.40E-05			g	Technosphere	Malaysia
	Input	Refined resource	Chip (silicon)	6.48E-04			g	Technosphere	Malaysia
	Input	Refined resource	Copper leadframe	5.58E-03			g	Technosphere	Malaysia
	Input	Refined resource	Die attach (silver)	2.15E-04			g	Technosphere	Malaysia
	Input	Refined resource	Electricity	2.30E-02			MJ	Technosphere	Malaysia
	Input	Refined resource	Gold wire	2.70E-05			g	Technosphere	Malaysia
	Input	Refined resource	Mold compound (silica)	7.47E-03			g	Technosphere	Malaysia
Notes: solder	Input	Refined resource	Sn	7.00E-04			g	Technosphere	Malaysia
	Output	Product	Integrated circuit comparator	1.47E-02			g	Technosphere	Malaysia
	Output	Residue	Hazardous waste	2.89E-01			g	Technosphere	Malaysia

About Inventory	
Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed integrated circuit comparator is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which

	process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP
Functional Unit	0.37 grams of integrated circuit interface
Functional Unit Explanation	Integrated circuit interface is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown

Technical system description	An integrated circuit is a small chip that consists of a small wafer with semiconductor devices such as transistors, resistors and capacitors. It is manufactured in a surface of a thin semiconductor material. An integrated circuit interface is a connector between integrated circuit and outer devices. The studied product consists of silicon (die), tin (plating), mold compound (silica), epoxy (die attach), copper (leadframe) and gold (wire). It weighs is produced in Singapure and transported to Motala, Sweden. The manufacturing process of integrated circuit is presented in the reference report: (excerpt from the report, see 'Publication') ''Regarding the process of manufacturing, wafer mounting and sawing are performed as the first step in the process. Afterwards, Die attach is bounded to the lead frame. Later on, the processes of snap cure, wire bonding, molding, post mode cure, deflashing, plating and cropping are performed in turn. Lastly, manufacturing of integrated circuit is ended up with labeling and packing''. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with wafer mounting and sawing and ends with labelling and packing. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Singapure.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation proces
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Copper leadframe	1.00E-01			g	Technosphere	Singapore

	Input	Refined resource	Electricity	1.69E+00			MJ	Technosphere	Singapore
	Input	Refined resource	Epoxy die attach (silver)	1.60E-03			g	Technosphere	Singapore
	Input	Refined resource	Gold wire	4.60E-03			g	Technosphere	Singapore
	Input	Refined resource	Mold compound (silica)	2.44E-01			g	Technosphere	Singapore
	Input	Refined resource	Silicon die	1.57E-02			g	Technosphere	Singapore
Notes: for plating	Input	Refined resource	Sn	4.20E-03			g	Technosphere	Singapore
	Output	Product	Integrated circuit interface	3.70E-01			g	Technosphere	Singapore

About Inventory	
Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed integrated circuit interface is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y

Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP
Functional Unit	0.685 gram of integrated circuit MCU
Functional Unit Explanation	Integrated circuit MCU is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	An integrated circuit is a small chip that consists of a small waffer with semiconductor devices such as transistors, resistors and capacitors. It is manufactured in a surface of a thin semiconductor material. A MCU is microcontroller unit has a function of storing the information for example software or various parameters. In the reference report the content of MCU is the same as integrated circuit Memory. The studied product consists of silicon (die), tin (plating), mold compound, epoxy (die attach), copper (leadframe) and gold (wire). It is produced in Muar Johore, Malaysia and transported to Motala, Sweden. The manufacturing process of integrated circuit is presented in the reference report: (excerpt from the report, see 'Publication') ''regarding the process of manufacturing, wafer mounting and sawing are performed as the first step in the process. Afterwards, Die attach is bounded to the lead frame. Later on, the processes of snap cure, wire bonding, molding, post mode cure, deflashing, plating and cropping are performed in turn. Lastly, manufacturing of integrated circuit is ended up with labeling and packing''. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with wafer mounting and sawing and ends with labelling and packing. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Muar Johare, Malaysia.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data. MCU - micro controller unit

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Copper leadframe	1.63E-01			g	Technosphere	Malaysia
	Input	Refined resource	Electricity	4.64E-05			MJ	Technosphere	Malaysia
	Input	Refined resource	Epoxy die attach (silver)	2.20E-03			g	Technosphere	Malaysia
	Input	Refined resource	Gold wire	1.70E-03			g	Technosphere	Malaysia
	Input	Refined resource	Mold compound	4.70E-01			g	Technosphere	Malaysia
Notes: Used for die	Input	Refined resource	Silicon die	3.93E-02			g	Technosphere	Malaysia
	Input	Refined resource	Sn	9.90E-03			g	Technosphere	Malaysia
	Output	Product	Integrated circuit MCU	6.85E-01			g	Technosphere	Malaysia

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed integrated circuit MCU is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is

	sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit’s label manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit’s label manufacturing. Autoliv ESA-DBP
Functional Unit	1 label
Functional Unit Explanation	1 label weighs 0.1 gram and is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A label has an information function. In the case of electronic control unit, it consists of a film, top coating and adhesive acrylic. The manufacturing process starts with laying the acrylic adhesive on the surface of a film which is followed by top coating. The manufacturing process takes place in the plant which is located in Åstorp, Sweden from where is transported to Autoliv in Motala, Sweden. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv’s Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit’s housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It relates to applying 2 additional layers on the film. There is no information about the emissions.
Time Boundary	The data were acquired in 2009/2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Åstorp, Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': "Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included."
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data. MCU - micro controller unit

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Acrylic adhesive	2.40E-02			g	Technosphere	Sweden
	Input	Refined resource	Electricity	1.32E-02			MJ	Technosphere	Sweden
	Input	Refined resource	Film	7.50E-02			g	Technosphere	Sweden
	Input	Refined resource	Top coat	1.00E-03			g	Technosphere	Sweden
	Output	Product	Label	1.00E-01			g	Technosphere	Sweden

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed label is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): "1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts."
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for

	environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit’s MEMS based sensor manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit’s MEMS based sensor manufacturing. Autoliv ESA-DBP
Functional Unit	0.759 gram of sensor
Functional Unit Explanation	The sensor is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''MEMS-Based Sensor is manufactured by our sensor supplier in Japan, which is used to sense and control the surrounding environment. (...) The sensor mounted on PCB board, mainly consists of silicon die, mold compound, copper leadframe and tin plating. (...) Manufacturing of sensor is starting from etching cavities in glass and electrodes. Next, bonding between SOI wafer and glass is conducted, and then back silicon wafer is etched. Afterward, lithographically pattern is performed to release silicon microstructures. Finally, manufacturing process of sensor is ended up with testing and sent to customers later on.'' This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP

	- Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with etching cavities in glass and eletrodes and ends with testing. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer of sensor is located in Japan.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Copper leadframe	2.01E-01			g	Technosphere	Japan
	Input	Refined resource	Die attach (siloxanes and silicons)	6.60E-03			g	Technosphere	Japan
	Input	Refined resource	Electricity	1.97E+00			MJ	Technosphere	Japan
	Input	Refined resource	Epoxy die attach (silver)	2.19E-03			g	Technosphere	Japan
	Input	Refined resource	Lead glass	8.50E-04			g	Technosphere	Japan
	Input	Refined resource	Mold compound (silica)	5.10E-01			g	Technosphere	Japan
	Input	Refined resource	Silicon die	2.44E-02			g	Technosphere	Japan
Notes: for plating	Input	Refined resource	Sn	9.90E-03			g	Technosphere	Japan
	Output	Product	Sensor	7.59E-01			g	Technosphere	Japan
	Output	Residue	Hazardous waste	1.31E+00			g	Technosphere	Japan
Date concieved: 2010 Data type: Derived, unspecified Represents: See 'Function' Method: Data gathered from manufacturer using data collection sheet. Literature: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg,	Output	Residue	Non hazardous waste	4.03E+00			g	Technosphere	Japan

Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf									

About Inventory	
Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed sensor is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit’s Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP
Functional Unit	46.6 grams of a PCB board
Functional Unit Explanation	PCB board is a part of electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Excerpt from the report, see ’Publication’: ’’PCB board is playing an indispensable part in entire PCB, which is acted as a carrier to mount every electronic component on the board. Besides, PCB board is also performed as a bridge, it makes electronic signal transforms via the board’s conductive paths.’’ The studied PCB base is made of copper, glass fibre, epoxy resin and silver. It weighs 46.6 grams and it is manufactured in the plant located in the east of China and then transported to Autoliv Motala, Sweden. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv’s Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit’s label manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is gate-to-gate. It starts with manufacturing laminated sheet of plastic and ends with testing the final product. Data given show only air emission and waste water production.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The product is manufactured in the plant in GuangZhou in China.
Other Boundaries	Excerpt from the report, see ’Publication’: ’’Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.’’
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	2010
Data Type	Derived, unspecified
Represents	See ’Function’
Method	Unknown

Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: The part's name in the reference report is 'PCB board' In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Water	8.04E-02			m3	Technosphere	China
Notes: NB: In the report it say 'water use'	Input	Natural resource	Water	8.04E-02			m3	Technosphere	China
	Input	Refined resource	Ag	1.00E-02			g	Technosphere	China
	Input	Refined resource	Cu	9.18E+00			g	Technosphere	China
	Input	Refined resource	Electricity	8.93E+00			MJ	Technosphere	China
Notes: NB: in the report it says 'city electricity'	Input	Refined resource	Electricity	8.93E-07			MJ	Technosphere	China
	Input	Refined resource	Epoxy resin	1.72E+01			g	Technosphere	China
	Input	Refined resource	Glass fibre	1.86E+01			g	Technosphere	China
Notes: Ink is used for screen printing	Input	Refined resource	Ink	1.61E+00			g	Technosphere	China
Notes: NB: not specified in the report	Output	Emission	Air emission	3.24E+01			m3	Air	China
	Output	Product	PCB board	4.66E+01			g	Technosphere	China
	Output	Residue	Waste water	5.64E-02			m3	Technosphere	China

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed PCB board is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed.

	It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit’s rectifier diode manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit’s rectifier diode manufacturing. Autoliv ESA-DBP
Functional Unit	0.064 grams of diode rectifier
Functional Unit Explanation	1 diode rectifier is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A diode is a two-terminal electronic component that conducts electric current in only one direction. A rectifier diode is used for converting alternating current to direct current. The studied one consists of copper (sheet), silicon, quartz, tin (for plating) and lead (solder). The general description of production process was contained in the report (excerpt from the report, see ’Publication’): ’’Manufacturing of diode begins with wafer sawing. Secondly, silicon die bonding and soldering are conducted. Thirdly, moulding and de-flashing are followed by. Afterward, the initial diodes are formed. Next, products are sent to test and mark. Finally, diodes are packed for delivering.’’ This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv’s Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit’s label manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s electronic connector manufacturing. Autoliv ESA-DBP

	- Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with wafer sawing and ends wirth testing and marking. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Tianjin, China.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	2.42E-06			m3	Water	China
	Input	Refined resource	Cu	2.30E-02			g	Technosphere	China
	Input	Refined resource	Electricity	3.75E-04			MJ	Technosphere	China
Notes: solder	Input	Refined resource	Pb	2.50E-03			g	Technosphere	China
	Input	Refined resource	Quartz (SiO2)	3.56E-02			g	Technosphere	China
	Input	Refined resource	Silicon, Si	1.30E-03			g	Technosphere	China
Notes: plate	Input	Refined resource	Sn	1.60E-03			g	Technosphere	China
	Output	Product	Diode rectifier	6.40E-02			g	Technosphere	China
	Output	Residue	Waste water	8.11E-07			m3	Technosphere	China

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed diode rectifier is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .

Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP
Functional Unit	0.00068 gram of resistor
Functional Unit Explanation	Resistor is a part of electronic control unit of which the total weight is 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''The resistor is one of the most common used electronic components in PCB, it is mainly used to restrict and reduce the flow of electric current in an electronic circuit. There are many pieces of resistor used in this studied ECU, which part of them are manufactured at one supplier in Malaysia. And other items are produced at one supplier, in Taiwan. Additionally, all of these resistors are the type of thick film resistor and mainly contain raw materials of solder, nickel, aluminium oxide part and electrode (silver). (...) Even though these resistors are produced in different plants, the manufacturing processes are almost same for this product. Firstly, incoming materials are inspected by the plants followed by printing the front and back terminals. Meanwhile, resistive elements and glass coat are printed as well as terminals. Following printing, aging of resistors is conducted before QC

	test. Finally, the manufacturing processes are finished, and all products get ready to be delivered. Speaking of transportation, since both these two manufacturing plants are located in Asia, therefore, products are supposed to pass by one of the European harbors, after that are delivered to Autoliv Motala.'' The resistors are placed in a printed circuit board. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with inspection of the incoming materials and ends with quality control. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The resistors for this particular are produced in Malaysia and Taiwan.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Aluminium oxide	5.81E-04			g	Technosphere	
	Input	Refined resource	Electricity	1.81E-03			MJ	Technosphere	
	Input	Refined resource	Epoxy resin	1.10E-05			g	Technosphere	
	Input	Refined resource	Glass ovecoat	1.40E-05			g	Technosphere	
	Input	Refined resource	Ni	1.60E-05			g	Technosphere	
	Input	Refined resource	Ruthenium dioxide	1.40E-05			g	Technosphere	
	Input	Refined resource	Silver-palladium electrode	1.00E-05			g	Technosphere	
	Input	Refined resource	Solder	1.40E-05			g	Technosphere	

	Output	Product	Resistor thick film	6.80E-04		g	Technosphere	

About Inventory	
Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed resistor is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP
Functional Unit	0.011 gram of resonator
Functional Unit Explanation	Resonator is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''Resonator is an electronic component that could indicate resonance of narrow range frequencies, which is used for concentrating electric fields in ECU. (...) The resonator company starts produce resonator by calcinating the mixed raw materials to form the ceramic body. Subsequently, the processes of sintering, lapping, polarizing, aging and cutting are performed in turn. Later on, before the outgoing inspection, all prepared resonators are conducted to be sorted, marked and tapped.'' The resonator is made of silver electrode, ceramic, aluminium oxide and plating layers.It is a one of the parts of Printed Circuit Board and it is produced in Japan and then transported to Autoliv Motala. This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is gate-to-gate. It starts with calcinating raw materials and ends with inspection and marking. Data given by resonator manufacturer show only waste water production. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturing plant is located in Japan.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'

Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Acrylic	9.81E-07			g	Technosphere	Japan
	Input	Refined resource	Aluminium oxide	9.39E-03			g	Technosphere	Japan
	Input	Refined resource	Ceramic	9.22E-04			g	Technosphere	Japan
	Input	Refined resource	Electricity	2.52E-02			MJ	Technosphere	Japan
	Input	Refined resource	Electrode silver	3.84E-04			g	Technosphere	Japan
	Input	Refined resource	Epoxy resin	2.06E-04			g	Technosphere	Japan
	Input	Refined resource	Phenol	4.91E-05			g	Technosphere	Japan
	Input	Refined resource	Plating gold	2.45E-05			g	Technosphere	Japan
	Input	Refined resource	Plating nickel	2.45E-05			g	Technosphere	Japan
Notes: The product weighs 0.011 gram	Output	Product	Resonator	1.10E-02			g	Technosphere	Japan
	Output	Residue	Waste water	8.50E-05			m3	Technosphere	Japan

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed resonator is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before

	the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit’s Schottky diode manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit’s Schottky diode manufacturing. Autoliv ESA-DBP
Functional Unit	0.064 gram of Schottky diode
Functional Unit Explanation	Schottky diode is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A diode is a two-terminal electronic component that conducts electric current in only one direction. A Schottky diode has a low forward voltage drop and a very fast switching action. The studied one consists of copper (sheet), silicon, quartz, tin (for plating) and lead (solder). The ready product is mounted on a printed circuit board. The general description of production process was contained in the report (excerpt from the report, see 'Publication'): ''Manufacturing of diode begins with wafer sawing. Secondly, silicon die bonding and soldering are conducted. Thirdly, moulding and de-flashing are followed by. Afterward, the initial diodes are formed. Next, products are sent to test and mark. Finally, diodes are packed for delivering.'' This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv’s Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit’s label manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s transistor manufacturing. Autoliv ESA-DBP

	- Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with wafer sawing and ends wirth testing and marking. Data show also waste water production. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Tianjin, China.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	2.42E-06			m3	Water	China
	Input	Refined resource	Cu	2.32E-02			g	Technosphere	China
	Input	Refined resource	Electricity	3.75E-04			MJ	Technosphere	China
Notes: solder	Input	Refined resource	Pb	2.55E-03			g	Technosphere	China
	Input	Refined resource	Quartz (SiO2)	3.53E-02			g	Technosphere	China
	Input	Refined resource	Silicon, Si	1.25E-03			g	Technosphere	China
Notes: plate	Input	Refined resource	Sn	1.63E-03			g	Technosphere	China
	Output	Product	Schottky diode	6.40E-02			g	Technosphere	China
	Output	Residue	Waste water	8.11E-07			m3	Technosphere	China

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed Schottky diode is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .

Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP
Functional Unit	1 screw
Functional Unit Explanation	1 screw weighs 0.71 grams and 7 screws are needed in 1 unit of electronic control unit.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A screw is usually used for fastening the parts. There might be different sizes, materials and other parameters. The studied screw is 30x8 and it is made of steel, e-plate zinc and passivation layer of Zn/ZnFe/ZnNi. There are 7 screws in electronic control unit and they are manufactured in Bad Berleburg in Germany and then transported to Örebro, Sweden. Each of them weighs 0.71 gram. The manufacturing process consists of the following steps: 1. Creating the headed rivet 2. Degreasing 3. Forming the thread 4. Degreasing

	5. Heat treatment 6. Plating 7. Inspection 8. Packaging This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with creating a headet rivet and ends with inspection and packing. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Bad Berleburg, Germany. It was assumed that electricity comes from the same country.
Other Boundaries	Excerpt from the report, see 'Publication': "Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included."
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	6.00E-04			MJ	Technosphere	Germany
	Input	Refined resource	e-plate zinc	7.12E-03			g	Technosphere	Germany
	Input	Refined resource	Passivation layer Zn/ZnFe/ZnNi	4.00E-05			g	Technosphere	Germany
Notes: In the report as 'material for fasteners property class'	Input	Refined resource	Steel	7.10E-01			g	Technosphere	Germany

Notes: 1 screw weighs 0.71 grams and is transported to Autoliv Motala in Sweden.	Output	Product	Screw	1			pce	Technosphere	Germany

About Inventory	
Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed screw is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP
Functional Unit	0.0076 gram of signal diode
Functional Unit Explanation	Signal diode is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A diode is a two-terminal electronic component that conducts electric current in only one direction. The studied consists of silver (diepad plating), silicon, copper (wire), gold (wire), glass and tin (for plating). The ready product is mounted on a printed circuit board. The general description of production process was contained in the report (excerpt from the report, see 'Publication'): ''Manufacturing of diode begins with wafer sawing. Secondly, silicon die bonding and soldering are conducted. Thirdly, moulding and de-flashing are followed by. Afterward, the initial diodes are formed. Next, products are sent to test and mark. Finally, diodes are packed for delivering.'' This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is gate-to-gate. It starts with wafer sawing and ends wirth testing and marking. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Singapure.
Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData	
Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown

Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Diepad plating	Input	Refined resource	Ag	2.13E-04			g	Technosphere	Singapore
	Input	Refined resource	Copper wire	3.34E-03			g	Technosphere	Singapore
	Input	Refined resource	Electricity	2.08E-02			MJ	Technosphere	Singapore
	Input	Refined resource	Glass	3.70E-03			g	Technosphere	Singapore
	Input	Refined resource	Gold wire	8.00E-06			g	Technosphere	Singapore
	Input	Refined resource	Silicon, Si	7.60E-05			g	Technosphere	Singapore
	Input	Refined resource	Sn	2.58E-04			g	Technosphere	Singapore
	Output	Product	Signal diode	7.60E-03			g	Technosphere	Singapore

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed signal diode is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP
Functional Unit	0.121 gram of transistor
Functional Unit Explanation	There are 4 of the transistors in the electronic control unit.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A transistor is used for amplifying or switching the electronic signals. In the studied transistor, the semicondutor is made of silicon. Except for this material there are also silver (attaching and plating), copper (frame), gold (wire), silica (encapsulation) and tin (frame). The manufacturing process is presented below (excerpt from the report, see 'Publication'): ''In perspective of manufacturing process, production of transistor starts with bonding of silicon crystal die on the lead frame. Then, wire bounding and encapsulation (with epoxy plastic) are conducted by the manufacturing plant. Afterward, all components are soldered and tinplated. The last step is to trim unwanted edges, and then packing is performed for transporting to customers.'' This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit's label manufacturing. Autoliv ESA-DBP - Electronic Control Unit's housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit's screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit's inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit's resistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's TVS diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is gate-to-gate. It starts with bonding of silicon crystal die on the lead frame and ends with trimming the outstanding edges. There is no information about the emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Kulim, Malaysia.

Other Boundaries	Excerpt from the report, see 'Publication': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: For diepad plating	Input	Refined resource	Ag	2.29E-03			g	Technosphere	Malaysia
	Input	Refined resource	Chip (silicon)	1.81E-03			g	Technosphere	Malaysia
	Input	Refined resource	Copper leadframe	5.88E-02			g	Technosphere	Malaysia
Notes: For attaching	Input	Refined resource	Die attach (silver)	2.41E-04			g	Technosphere	Malaysia
	Input	Refined resource	Electricity	5.69E-03			MJ	Technosphere	Malaysia
	Input	Refined resource	Encapsulation (silica)	5.59E-03			g	Technosphere	Malaysia
Notes: For wire	Input	Refined resource	Gold wire	1.21E-04			g	Technosphere	Malaysia
Notes: Leadframe	Input	Refined resource	Sn	1.33E-03			g	Technosphere	Malaysia
	Output	Product	Transistor	1.21E-01			g	Technosphere	Malaysia

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed transistor is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).

Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Electronic Control Unit’s TVS diode manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-08-05
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Electronic Control Unit’s TVS diode manufacturing. Autoliv ESA-DBP
Functional Unit	0.11 gram of TVS diode
Functional Unit Explanation	TVS diode is a part of an electronic control unit which weighs 427.07 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A diode is a two-terminal electronic component that conducts electric current in only one direction. A TVS (Transient Voltage Suppression) diode is used to suppress overvoltage when the induced voltage exceeds the avalanche breakdown potential. The studied diode consists of die TVS set, gold (wire), alloy, silver (solder), EP glass, tin (plate) and copper (plate). The ready product is mounted on a printed circuit board. The general description of production process was contained in the report (excerpt from the report, see ’Literature reference’): ’’Manufacturing of diode begins with wafer sawing. Secondly, silicon die bonding and soldering are conducted. Thirdly, moulding and de-flashing are followed by. Afterward, the initial diodes are formed. Next, products are sent to test and mark. Finally, diodes are packed for delivering.’’ This process is included in the system described in: Gu S., Liu J. (2010). Life cycle assessment of Autoliv’s Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf Other processes in the CPM Database also included in the above publication: - Electronic Control Unit’s label manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s housing manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s screw manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s inductor manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resonator manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s Printed Circuit Board (PCB) base manufacturing. Autoliv ESA-DBP - Electronic Control Unit’s resistor manufacturing. Autoliv ESA-DBP

	- Electronic Control Unit's aluminium capacitor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's sensor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's rectifier diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's Schottky diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's signal diode manufacturing. Autoliv ESA-DBP - Electronic Control Unit's electronic connector manufacturing. Autoliv ESA-DBP - Electronic Control Unit's transistor manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit ASIC manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit MCU/memory manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit interface manufacturing. Autoliv ESA-DBP - Electronic Control Unit's integrated circuit comparator manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with wafer sawing and ends wirth testing and marking. Data show also air emissions.
Time Boundary	The data were acquired in 2010 as the most up-to-date ones.
Geographical Boundary	The manufacturer is located in Malaysia.
Other Boundaries	Excerpt from the report, see 'Publication': "Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included."
Allocations	NB: In the reference report there is no information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--9.pdf
Notes	NB: In the reference report there is no information about the source of the data. TVS - Transient Voltage Suppression

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Water	9.28E-02			l	Water	Malaysia
Notes: solder	Input	Refined resource	Ag	1.42E-03			g	Technosphere	Malaysia
Notes: plating	Input	Refined resource	Cu	2.70E-03			g	Technosphere	Malaysia
	Input	Refined resource	Die TVS set	6.15E-03			g	Technosphere	Malaysia
	Input	Refined resource	Electricity	4.64E-05			MJ	Technosphere	Malaysia
	Input	Refined resource	EP glass	7.11E-02			g	Technosphere	Malaysia
	Input	Refined resource	Gold wire	1.40E-03			g	Technosphere	Malaysia
	Input	Refined resource	Iron and nickel alloy	3.09E-02			g	Technosphere	Malaysia
Notes: plate	Input	Refined resource	Sn	9.35E-04			g	Technosphere	Malaysia
	Output	Emission	SO2	3.10E-04			g	Air	Malaysia
	Output	Product	TVS diode	1.10E-01			g	Technosphere	Malaysia

About Inventory

Publication	Gu S., Liu J. (2010). Life cycle assessment of Autoliv's Electronic Control Unit. Master thesis report. ESA report 2010:5, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--9.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.

Detailed Purpose	The discussed TVS diode is a part of the electronic control unit which was the object of the study. The main goals of the study are (excerpt from the report, see 'Publication'): ''1.What kind of environmental impacts can be associated with ECU production? In which process life cycle of ECU production has the biggest responsibility for adverse environmental impacts? 2. Analyses on different environmental impacts as potential, calculate the consumption of different energy resources, and quantities of waste in all life cycle. 3. Decide which materials in the ECU could be avoided for better environmental impacts.''
Commissioner	Autoliv Development AB - .
Practitioner	Suyang Gu & Jingjing Liu - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The general function of an electronic control unit is controlling the internal systems in a vehicle. It controls and manages safety equipment. It gathers and processes signals from the sensors located in the car in order to cause an action if needed. It was assumed in the report that an electronic control unit is dismantled from a car before the latter is squashed into the cube and shredded. The electronic control unit is then disassembled into some segments. Plastic parts are recovered as energy whereas the metal parts are recycled. The most crucial part - PCB (printed circuit board) as a separate part is sent to the special oven and as a result of this process metals are recycled in a rate of 96-99% when the plastics are recovered as energy. The studied product is a part of the electronic control unit which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the electronic control unit, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and night vision camera). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Ethanol from sugar beets, cradle-to-gate, energy allocation - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Ethanol from sugar beets, cradle-to-gate, energy allocation - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of ethanol from sugar beets
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	

Technical system description	This dataset represents a model of the production of ethanol from sugar beets valid for southern Sweden. The following process are covered: - Cultivation of the sugar beets - Harvest - Distribution to the fuel plant - Production of ethanol The mineral fertilizer used is assumed partly to be produced in Western Europe (about 60 %) with present level of cleaning equiptment etc., and partly imported from countries outside Europe (about 40 %). This implies that about 30 % of the mineral fertilizer production takes place in plants with nitrous oxide cleaning where the nitrous oxide emission levels are reduced with about 80 %. All electricity input in the ethanol-plant is Swedish grid mix. Fuel used at the ethanol plant for is of forest origin. Allocation is made based on energy content (only case published in "Miljöfaktaboken" (see references), since this allocation method is preferred by the Renewable Energy Directive), however a case with system expansion is made in Börjesson et al. which also has been published in the f3 database. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included. Impacts from production of buildings and infrastructure are not included. Börjesson et al. publishes both a case with allocation and a case with system expansion. In the f3 fuels data project, both these data sets are published.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Cultivation of sugar beets (assumed on good soil) and handeling and storing of waste and manure is in southern Sweden.
Other Boundaries	
Allocations	Allocation is only done in the ethanol production. The outputs from the ethanol production are ethanol and the by-product pulp. Emissions and primary energy demand are allocated between the ethanol and the pulp. Energy allocation is based on the following energy contents: sugar beet 17,6 MJ/kg, pulp 16,8 MJ/kg
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	Literature studies
Literature Reference	Gode, J. et al., 2011, Miljöfaktaboken 2011, Uppskattade emissionsfaktorer för bränslen, el, värme och transporter, Värmeforsk Data in Gode et al. Are based on: Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH. But since data in Börjesson et al. is only given in impact categories not per emissions Gode et al. is used.
Notes	NB: In the reference report there is no information about the source of the data. TVS - Transient Voltage Suppression

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Energy use and the energy embedded in the product. Börjesson is not stating what different energy carriers that are included in the primary energy. There is no primary energy factor given.	Input	Resource	Primary energy	12.8			MJ	Ground	
	Output	Emission	Carbon dioxide (fossil)	0.0089			kg	Air	
	Output	Emission	Carbon monoxide	0.0000097			kg	Air	
Notes: Methane emissions can vary extensively between sites. These are average data for southern Sweden.	Output	Emission	Methane (biogenic)	0.000012			kg	Air	

	Output	Emission	Nitrate	-0.00036				Water	
	Output	Emission	Nitrogen oxides	0.000058			kg	Air	
	Output	Emission	Nitrous oxide	0.0000059			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	0.0000026			kg	Air	
	Output	Emission	Particles (unspecified)	0.0000027			kg	Air	
	Output	Emission	Sulfur dioxide	0.0000096			kg	Air	
	Output	Product	Ethanol from sugar beets	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Ethanol from sugar beets, cradle-to-gate, system expansion, impact categories only - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Ethanol from sugar beets, cradle-to-gate, system expansion, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of ethanol from sugar beets.
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	

Technical system description	This dataset represents a model of the cradle to gate production of ethanol from sugar beets valid for southern Sweden. The following process are covered: - Cultivation of the sugar beets - Harvest - Distribution to the fuel plant - Production of ethanol The mineral fertilizer used is assumed partly to be produced in Western Europe (about 60 %) with present level of cleaning equiptment etc., and partly imported from countries outside Europe (about 40 %). This implies that about 30 % of the mineral fertilizer production takes place in plants with nitrous oxide cleaning where the nitrous oxide emission levels are reduced with about 80 %. All electricity input in the ethanol-plant is Swedish grid mix. Fuel used at the ethanol plant for is of forest origin. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included. Impacts from production of buildings and infrastructure are not included. Data in Börjesson et al. are only published as impact categories and not as emissions except for particles. The amount of primary energy is not mentioned either. Börjesson et al. publishes both a case with allocation and a case with system expansion. In the f3 fuels data project, both these data sets are published.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Cultivation of sugar beets (assumed on good soil) and handeling and storing of waste and manure is in southern Sweden.
Other Boundaries	
Allocations	No.
Systems Expansions	The ethanol production process is generating the by-product pulp. 1 kg pulp (dry matter) is replacing 1 kg barley. Reference: Table 2 and figure 1

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	Raw material: General – Processed official statistics Transformation: Mainly general – Preliminary studies & International Reference: Table 1
Literature Reference	Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH.
Notes	NB: In the reference report there is no information about the source of the data. TVS - Transient Voltage Suppression

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Not mentioned in Börjesson	Input	Resource	Primary energy	0			MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. Table 10	Output	Emission	Acidification (AP)	0.000018			kg	Air	
Notes: Given as kg PO4-eq combined emissions. Table 9	Output	Emission	Eutrophication (EP)	-0.000056			kg	Air	
Notes: Given as kg CO2-eq combined emissions. Table 7	Output	Emission	Global warming (GWP)	0.0169			kg	Air	
Notes: Table 12	Output	Emission	Particles (unspecified)	0.0000066			kg	Air	
Notes: Given as kg ethene-eq combined emissions. Table 11	Output	Emission	Photo-oxidant formation (POCP)	0.0000032			kg	Air	
	Output	Product	Ethanol from sugar beets	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Ethanol from sugar cane, cradle-to-gate, energy allocation, impact categories only - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Ethanol from sugar cane, cradle-to-gate, energy allocation, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of ethanol from sugar cane
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of ethanol from sugar cane. The following processes are covered: - Cultivation of the sugar cane - Harvest - Distribution to the fuel plant - Production of ethanol - Transportation of ethanol from Brazil to a Swedish port Indirect land use change is considered not to occur, as there are no confirmed links under current situation (Berndes et al, 2010 in Börjesson et al 2010). Data in Börjesson et al. are only published as impact categories and not as emissions except for particles. The amount of primary energy is not mentioned either. Börjesson et al. publishes both a case with allocation and a case with system expansion. In the f3 fuels data project, both these data sets are published.

System Boundaries	
Nature Boundary	

Time Boundary	2010 - 2013
Geographical Boundary	Brazil
Other Boundaries	
Allocations	Energy allocation between ethanol and excess electricity from the production step.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	Literature studies of Brazilian ethanol production. General data.
Literature Reference	Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH.
Notes	NB: In the reference report there is no information about the source of the data. TVS - Transient Voltage Suppression

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Not mentioned in Börjesson	Input	Resource	Primary energy	0			MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. Table 10	Output	Emission	Acidification (AP)	0.000229			kg	Air	
Notes: Given as kg PO4-eq combined emissions. Table 8	Output	Emission	Eutrophication (EP)	0.000062			kg	Air	
Notes: Given as kg CO2-eq combined emissions. Table 7	Output	Emission	Global warming (GWP)	0.0189			kg	Air	
Notes: Table 12	Output	Emission	Particles (unspecified)	0.0000087			kg	Air	
Notes: Given as kg ethene-eq combined emissions. Table 11	Output	Emission	Photo-oxidant formation (POCP)	0.000024			kg	Air	
	Output	Product	Ethanol from sugar cane	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Ethanol from sugar cane, cradle-to-gate, system expansion, impact categories only - f3 fuels

Administrative

Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System

Name	Ethanol from sugar cane, cradle-to-gate, system expansion, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of ethanol from sugar cane
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	"This dataset represents a model of the cradle to gate production of ethanol from sugar cane. The following process are covered: - Cultivation of the sugar cane - Harvest - Distribution to the fuel plant - Production of ethanol - Transportation of ethanol from Brazil to a Swedish port Indirect land use change is considered not to occur, as there are no confirmed links under current situation (Berndes et al, 2010 in Börjesson et al 2010). Data in Börjesson et al. are only published as impact categories and not as emissions except for particles. Börjesson et al. publishes both a case with allocation and a case with system expansion. In the f3 fuels data project, both these data sets are published."

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Brazil
Other Boundaries	
Allocations	No.
Systems Expansions	Excess electricity is replacing electricity based on natural gas.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	Literature studies of Brazilian ethanol production. General data.
Literature Reference	Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH.
Notes	NB: In the reference report there is no information about the source of the data. TVS - Transient Voltage Suppression

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*

Notes: Table A29. Energy use and the energy embedded in the product. Börjesson is not stating what different energy carriers that are included in the primary energy. There is no primary energy factor given.	Input	Resource	Primary energy	0.195			MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. Table 10	Output	Emission	Acidification (AP)	0.000241			kg	Air	
Notes: Given as kg PO4-eq combined emissions. Table 8	Output	Emission	Eutrophication (EP)	0.000068			kg	Air	
Notes: Given as kg CO2-eq combined emissions. Table 7	Output	Emission	Global warming (GWP)	0.0176			kg	Air	
Notes: Table 12	Output	Emission	Particles (unspecified)	0.000009			kg	Air	
Notes: Given as kg ethene-eq combined emissions. Table 11	Output	Emission	Photo-oxidant formation (POCP)	0.000026			kg	Air	
	Output	Product	Ethanol from sugar cane	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Ethanol from wheat, cradle-to-gate, energy allocation - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Ethanol from wheat, cradle-to-gate, energy allocation - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of ethanol from wheat
Process Type	Cradle to gate
Site	

Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the production of ethanol from wheat valid for southern Sweden. The following process are covered: - Cultivation of the wheat - Harvest - Distribution to the fuel plant - Production of ethanol The production of ethanol is assumed to take place at Agroetanol in Norrköping. The mineral fertilizer used is assumed partly to be produced in Western Europe (about 60 %) with present level of cleaning equiptment etc., and partly imported from countries outside Europe (about 40 %). This implies that about 30 % of the mineral fertilizer production takes place in plants with nitrous oxide cleaning where the nitrous oxide emission levels are reduced with about 80 %. All electricity input in the ethanol-plant is Swedish grid mix. Fuel used at the ethanol plant is of forest origin. Allocation is made based on energy content (only case published in "Miljöfaktaboken" (see references), since this allocation method is preferred by the Renewable Energy Directive), however a case with system expansion is made in Börjesson et al. which also has been published in the f3 database. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included. Impacts from production of buildings and infrastructure are not included.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Cultivation of wheat (assumed on good soil) and handeling and storing of waste and manure is in southern Sweden.
Other Boundaries	
Allocations	Allocation is only done in the ethanol production. For the outputs ethanol and the distillers waste energy allocation was applied. Energy contents: wheat 18,4 MJ/kg, distillers waste 17,3 MJ/kg.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	Literature studies of Brazilian ethanol production. General data.
Literature Reference	Gode, J. et al., 2011, Miljöfaktaboken 2011, Uppskattade emissionsfaktorer för bränslen, el, värme och transporter, Värmeforsk Data in Gode et al. Are based on: Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH. But since data in Börjesson et al. is only given in impact categories not per emissions Gode et al. is used.
Notes	NB: In the reference report there is no information about the source of the data. TVS - Transient Voltage Suppression

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Energy use and the energy embedded in the product. Börjesson is not stating what different energy carriers that are included in the primary energy. There is no primary energy factor given.	Input	Resource	Primary energy	1.48			MJ	Ground	
	Output	Emission	Carbon dioxide (fossil)	0.014			kg	Air	
	Output	Emission	Carbon monoxide	0.000013			kg	Air	

Notes: Methane emissions can vary extensively between sites. These are average data for southern Sweden.	Output	Emission	Methane (biogenic)	0.000023			kg	Air	
	Output	Emission	Nitrogen oxides	0.000058			kg	Air	
	Output	Emission	Nitrous oxide	0.000017			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	0.0000034			kg	Air	
	Output	Emission	Particles (unspecified)	0.0000054			kg	Air	
	Output	Emission	Sulfur dioxide	0.000026			kg	Air	
	Output	Product	Ethanol from wheat	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Ethanol from wheat, cradle-to-gate, system expansion, impact categories only - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Ethanol from wheat, cradle-to-gate, system expansion, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of ethanol from wheat
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	

Technical system description	This dataset represents a model of the cradle to gate production of ethanol from wheat valid for southern Sweden. The following processes are covered: - Cultivation of the wheat - Harvest - Distribution to the fuel plant - Production of ethanol The production of ethanol is assumed to take place in Agroetanol in Norrköping. The mineral fertilizer used is assumed partly to be produced in Western Europe (about 60 %) with present level of cleaning equiptment etc., and partly imported from countries outside Europe (about 40 %). This implies that about 30 % of the mineral fertilizer production takes place in plants with nitrous oxide cleaning where the nitrous oxide emission levels are reduced with about 80 %. All electricity input in the ethanol-plant is Swedish grid mix. Fuel used at the ethanol plant for is of forest origin. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included. Impacts from production of buildings and infrastructure are not included. Data in Börjesson et al. are only published as impact categories and not as emissions except for particles.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Cultivation of wheat (assumed on good soil) and handeling and storing of waste and manure is in southern Sweden.
Other Boundaries	
Allocations	No.
Systems Expansions	Distillers waste is generated in the production of ethanol. 1 kg distillers waste (dry matter) is replacing 0.4 kg soybean meal and 0.6 kg barley. Reference: Figure 1 and table 2.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	Raw material: General – Processed official statistics Transformation: Mainly site-specific – Norrköping – Existing Reference: Table 1
Literature Reference	Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH.
Notes	NB: In the reference report there is no information about the source of the data. TVS - Transient Voltage Suppression

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Not mentioned in Börjesson	Input	Resource	Primary energy	0			MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. Table 10	Output	Emission	Acidification (AP)	0.000065			kg	Air	
Notes: Given as kg PO4-eq combined emissions. Table 9	Output	Emission	Eutrophication (EP)	0.00017			kg	Air	
Notes: Given as kg CO2-eq combined emissions. Table 7	Output	Emission	Global warming (GWP)	0.0273			kg	Air	
Notes: Table 12	Output	Emission	Particles (unspecified)	0.0000022			kg	Air	
Notes: Given as kg ethene-eq combined emissions. Table 11	Output	Emission	Photo-oxidant formation (POCP)	0.0000016			kg	Air	
	Output	Product	Ethanol from wheat	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Ethylene production from cane based ethanol. ESA-DBP

Administrative	
Finished	Y
Date Completed	2009
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Ethylene production from cane based ethanol. ESA-DBP
Functional Unit	1 kg of ethylene
Functional Unit Explanation	1 kg of ethylene is needed to produce 1 kg of LDPE which is the object of the study.
Process Type	Gate to gate
Site	Unknown
Sector	Biological
Owner	Unknown
Technical system description	Ethylene production discussed in this study is a one of the steps of sugarcane based LDPE (low density polyethylene) production process. This process is gate-to-gate but the electricity and fuel used in this process are traced back to the cradle. In this step the ethanol is processed into the ethylene. Excerpt from the report: ''The following summarized description of the dehydration of ethanol to ethylene is in accordance to a patent held by Braskem, which was used to model the process in HYSYS and to thereby generate data. (...) The process starts with pumping the ethanol (at 13,73 bar) to the reactor. Before the reactor, the ethanol passes through two heat exchangers. In both exchangers, it is heated by a countercurrent flow of reactor product, which passes the exchangers before undergoing purification. However, before entering the second exchanger the ethanol is mixed with an ethylene-water vapor recycle from the reactor product. Leaving the second heat exchanger this mix is further heated to 481°C in a furnace before entering the adiabatic reactor (at 481°C and 11,93 bar). In the reactor, which is filled with alumina catalyst, the ethanol is dehydrated to ethylene. After an unspecified residence time the stream leaves the reactor and is split in the ratio 2:3 recycle flow to the flow of the end product. The remaining reactor product is further processed to remove impurities and receive PE grade ethylene.''

	This process is included in the system described in: Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2009--14.pdf Other processes in the CPM Database also included in the above publication: - Sugarcane cultivation. ESA-DBP - Refinery in crude oil based LDPE production process. ESA-DBP - Polymerization in crude oil based LDPE production process. ESA-DBP - Steam cracking in crude oil based LDPE production process. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''Outputs accounted for in this study were by-products and emissions released to air. Water emissions were omitted, because of data unavailability for some parts of the sugarcane route. Energy consumed along the process chain was traced back to the extraction of the energy carriers (fuels) needed for its generation.''
Time Boundary	The data for ethylene production come from the year 2007. Data for energy originated in 2004.
Geographical Boundary	The study was done for Brazil.
Other Boundaries	Excerpt from the report, see 'Publication': ''- patent does not include all processes up to final purification of ethylene (up to polymergrade ethylene) - patent does not state data on how much fuel is internal fuel and how much fuel is external fuel - not possible to receive information with process simulation - use of process simulation up to processes that are given, for other processes and data application of data from Kochar et al. (1981) Assumptions for Kochar et al data: - efficiencies for boilers for external & internal fuels are the same - internal & external fuels are treated as natural gas - all fuel is burned to create steam - in 'crude grade ethylene' scenario all fuel is external fuel - in 'polymer grade ethylene' scenario part of the by-products is burned (internal fuels) to produce steam - energy stated under power is electricity consumed - attributional approach - application of average Brazilian electricity supply mix data - ethylene consumption is based on anhydrous ethanol, simplification set = amount of anhydrous ethanol consumed = amount of hydrous ethanol consumed in this study''
Allocations	No allocation needed.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2007
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report: ''As already stated in the process description the data applied to assess this process partly originate from a patent held by Braskem(...). It was simulated in the process simulation program Aspen HYSYS. However, this patent does not include all steps up to the final purification of the ethylene. For this reason, the data generated from the process simulation were combined with data from a text released by Kochar et al. (1981). The text states the complete energy (in the form of electricity and fuels burned directly for the process) consumed to produce polymergrade PE as well as the specifications of the ethanol consumed - application of anhydrous ethanol. The energy consumed in the process is electricity and fuels directly burned for process purposes. Electricity consumed was assessed using the already stated data - see electricity consumption. All other energy carriers directly used in the plant were assumed to be natural gas. They were assessed according to data from Bargigli (2004) for the natural gas extraction and according to Baumann and Tillman (2004) for their combustion.
Literature Reference	Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2009--14.pdf
Notes	Data for attributional approach.

Flow Table and Specific Meta Data									
QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Ethanol	1.70E+03			g	Other	Brazil
	Input	Refined resource	Electricity	1.80E+00			MJ	Technosphere	Brazil
	Input	Refined resource	Fuel	5.60E+00			MJ	Technosphere	Brazil
	Output	Emission	CH4	1.50E+00			g	Air	Brazil
	Output	Emission	CO	2.00E-01			g	Air	Brazil
	Output	Emission	CO2	3.27E+02			g	Air	Brazil
	Output	Emission	N2O	1.20E-02			g	Air	Brazil
	Output	Emission	NMVOC	1.10E-02			g	Air	Brazil
	Output	Emission	NOx	1.50E+00			g	Air	Brazil
	Output	Emission	SO2	1.00E-01			g	Air	Brazil
	Output	Product	Ethylene	1.00E+03			g	Other	Brazil

About Inventory	
Publication	Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2009--14.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this study is to answer the question, is the use of sugarcane based LDPE in the production of goods and packing in Sweden environmentally preferable to crude oil based LDPE.''
Detailed Purpose	Ethylene production is a step in the production process of sugarcane based LDPE so it was necessary to investigate the environmental load of it.
Commissioner	Unknown - .
Practitioner	Christin Liptow & Anne-Marie Tillman - Environmental Systems Analysis, Chalmers University of Technology.
Reviewer	Tillman, Anne-Marie - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Ethylene production is a step in a production process of sugarcane based LDPE which was the object of the study. The production process starts with cane cultivation, ethanol production, ethylene production, polymerization, use phase (which is not included in the study) and ends with incineration. In the study sugarcane based- was compared with oil based- LDPE. NB: in the report two approaches were investigated: attributional and consequential. For consequential approach see the report.

SPINE LCI dataset: European average production of sodium carbonate (Solvay process)

Administrative	
Finished	Y
Date Completed	2003-03-10
Copyright	

Availability	Public

Technical System

Name	European average production of sodium carbonate (Solvay process)
Functional Unit	1 ton of Na_2CO_3 (sodium carbonate).
Functional Unit Explanation	1 ton of sodium carbonate produced at the plant.
Process Type	Gate to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	This activity describes the average production of sodium carbonate in Germany. The data represent average results for Western European soda production. The sodium carbonate is produced using the Solvay technique. The production process consists of the following steps: 1. brine cleaning, 2. manufacture of the product, 3. lime milk preparation, 4. NH3-recovery. The detailed description of each stage of the process is presented below. 1. SODIUM CARBONATE PRODUCTION (SOLVAY TECHNIQUE) The technical manufacture of soda (i.e. sodium carbonate) with the Solvay Technique is effected by the conversion of sodium chloride (salt) and calcium carbonate (limestone) according to the following reaction. (1) 2 NaCl + $CaCO_3$ ====> $CaCl_2$ + Na_2CO_3 Besides soda, the Solvay Technique also produces $CaCl_2$ as a by-product. The overall process can be divided into the following reaction steps: 1.1. Brine cleaning. a) Precipitation of magnesium hyfroxide and calcium carbonate by the addition of lime milk and soda solution into the brine: (2) Mg^{2+} + $Ca(OH)_2$ ====> $Mg(OH)_2$ + Ca^{2+} (3) Ca^{2+} + Na_2CO_3 ====> $CaCO_3$ + Na^{2+} 1.2. Manufacture of the product. a) Precipitation of the relatively heavy-soluble bicarbonate ($NaHCO_3$) by the addition of carbonic acid into a salt solution saturated with ammonia: (4) NaCl + H_2O + NH_3 + CO_2 ====> NH_4Cl + $NaHCO_3$ b) Thermic decomposition of the bicarbonate: (5) 2 $NaHCO_3$ ====> CO_2 + H_2O + Na_2CO_3 1.3. Lime milk preparation. a) Manufacture of caustic lime: (6) $CaCO_3$ ====> CaO + CO_2 b) manufacture of lime milk: (7) CaO + H_2O ====> $Ca(OH)_2$ 1.4. NH3-Recovery. a) Recovery of ammonia by distillation of ammonium chloride containing mother liquor and lime milk: (8) 2NH_4Cl + $Ca(OH)_2$ ====> 2NH_3 + 2H_2O + $CaCl_2$ 2. RAW MATERIALS FOR SODIUM CARBONATE PRODUCTION 2.1. Limestone. 2.2. Sodium chloride production. Sodium chloride exists naturally as salt deposits of varying purity. One method to extract sodium chloride is brine pumping. Water is pumped into a natural slat deposit when the slat dissolves to produce a sturated solution which may then be pumped to the surface for use. The main impurities present are magnesium, calcium and sulphate ions with a total typical concentration of 0,6 wt%. Another way of producing sodium chloride is rock salt mining. The impurities are similar to the process described above. 2.3. Ammonia production. Ammonia is mainly produced by the direct reaction of nitrogen with hydrogen. The usual source of hydrogen is from the steam reforming of natural gas. Air may be added to provide the nitrogen needed to produce ammonia.

	3. HEAT The fuels used in steam production vary widely from low grade lignite and brown coal through to natural gas, hydrogen (in some electrolysis plants), electricity (in countries where there is an abundant supply of cheap hydropower) and, in some instances, waste products from the production process itself. Data for this activity are the resulting average of all steam plants that have been examined in the course of the work by APME on chemicals and plastics, i.e. 215 plants. 4. ELECTRICITY Throughout the whole gate to gate inventory, electricity is required (710 MJ, i.e. 197.2 kWh). Information about electricity internal flows is given below: Electricity - biomass 3,8656 kWh Electricity - coal 55,7749 kWh Electricity - geo 0,9072 kWh Electricity - hydro 25,6785 kWh Electricity - natural gas 26,0335 kWh Electricity - nuclear 69,9947 kWh Electricity - oil 14,3382 kWh Electricity - wind 0,6614 kWh Literature reference: Final Report ''German Notes on BAT for the Production of Large Volume Solid Inorganic Chemicals. Soda''. Institut für Umwelttechnik und Management and der Universität Witten/Herdercke, UBA, June 2001. For more references see: ''About data''

System Boundaries

Nature Boundary	Environmental impact due to use of machinery, plants and infrastructures is not included. Consumption of energy and raw material resources as well as emissions to air and water are included.
Time Boundary	Data on sodium carbonate production were published in 2001. Data on heat and electricity production are from 1997.
Geographical Boundary	All scenarios are supposed to be situated in any Western European country.
Other Boundaries	Transportation of fuels to vehicles or energy plants is not included.
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	20021010/20030110
Data Type	Derived, mixed
Represents	This scenario represents the average production of sodium carbonate in Germany.
Method	Data based on information retrieved from the report shown below.
Literature Reference	Final Report ''German Notes on BAT for the Production of Large Volume Solid Inorganic Chemicals. Soda''. Institut für Umwelttechnik und Management and der Universität Witten/Herdercke, UBA, June 2001.
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	80			m3	Ground	
	Input	Refined resource	Ammonia	1.5			kg	Technosphere	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Average input of coke goes from 0.1 to 0.5 tons. Therefore an average value of 0.3 tons has been chosen.	Input	Refined resource	Coke	0.3			tonne	Technosphere	

Date concieved: 2003-03-17 Data type: Derived, mixed Represents: Average electricity production in European Union countries, i.e. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Swedem and the United Kingdom.	Input	Refined resource	Electricity	710			MJ	Technosphere	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Both demands of heat and steam aggregated. Notes: 3.7 GJ/ton soda needed for the overall process. Energy is manily demanded by the calcination of crude bicarbonate (including the filtermoist product drying). Energy produced by exothermic steps like the NH3-absorption (1.84 GJ/ton) and the carbonisation process (1.42 GJ/ton) have been already taken into account.	Input	Refined resource	Heat	3700			MJ	Technosphere	
	Input	Refined resource	Limestone	1.2			tonne	Technosphere	
Date concieved: 2003-03-17 Data type: Derived, mixed Notes: Sodium chloride is either mined in solid form (stone-salt) and dissolved in the brine, or it is won as saturated salt solution by salting-out mines.	Input	Refined resource	Sodium chloride	1.5			tonne	Technosphere	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Waste water data were calculated based on average measuring results of the official examinations carried out in 1999 at both Solvay Sosa Germany plant (Rheinberg) and Mathes & Weber plant (Duisburg). No. of measurements carried out at: Solvay Rheinberg: 21. Mathes & Weber: 8.	Output	Emission	Ca++	192.4			kg	Water	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Waste water data were calculated based on average measuring results of the official examinations carried out in 1999 at both Solvay Sosa Germany plant (Rheinberg) and Mathes & Weber plant (Duisburg). No. of measurements carried out at: Solvay Rheinberg: 21. Mathes & Weber: 8.	Output	Emission	Cd	0.17			g	Water	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Waste water data were calculated based on average measuring results of the official examinations carried out in 1999 at both Solvay Sosa Germany plant (Rheinberg) and Mathes & Weber plant (Duisburg). No. of measurements carried out at: Solvay Rheinberg: 21. Mathes & Weber: 8.	Output	Emission	Cl-	794.2			kg	Water	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: The present concentrations are average values taken from different measurements and systems. Data basis are: a) Average half-hour-measurements of esternal analysis institutes. b) Average concentrations from on-line measurements. c) Internal company measurements and calculations. Notes: Off-gas emission data based on the Emission Declaration of Solvay (1996) according to the 11th directive of the BImSchV (German Immission Directice).	Output	Emission	CO	3635			g	Air	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Waste water data were calculated based on average measuring results of the official examinations carried out in 1999 at both Solvay Sosa Germany plant (Rheinberg) and Mathes & Weber plant (Duisburg). No. of	Output	Emission	Cr	1.02			g	Water	

measurements carried out at: Solvay Rheinberg: 21. Mathes & Weber: 8.									
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Waste water data were calculated based on average measuring results of the official examinations carried out in 1999 at both Solvay Sosa Germany plant (Rheinberg) and Mathes & Weber plant (Duisburg). No. of measurements carried out at: Solvay Rheinberg: 21. Mathes & Weber: 8.	Output	Emission	Cu	1.58			g	Water	
Date concieved: 2003-03-17 Data type: Derived, mixed Represents: Overall dust emissions, whose composition (% weight) is: Ca (OH)2 8.6% CaO 45.7% CaCO3 20.7% Na2CO3 16.4% Coke 2.9% Rest 5.7% Method: The present concentrations are average values taken from different measurements and systems. Data basis are: a) Average half-hour-measurements of esternal analysis institutes. b) Average concentrations from on-line measurements. c) Internal company measurements and calculations. Notes: Off-gas emission data based on the Emission Declaration of Solvay (1996) according to the 11th directive of the BImSchV (German Immission Directice).	Output	Emission	Dust	14			g	Air	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Waste water data were calculated based on average measuring results of the official examinations carried out in 1999 at both Solvay Sosa Germany plant (Rheinberg) and Mathes & Weber plant (Duisburg). No. of measurements carried out at: Solvay Rheinberg: 21. Mathes & Weber: 8.	Output	Emission	Hg	0.002			g	Water	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Waste water data were calculated based on average measuring results of the official examinations carried out in 1999 at both Solvay Sosa Germany plant (Rheinberg) and Mathes & Weber plant (Duisburg). No. of measurements carried out at: Solvay Rheinberg: 21. Mathes & Weber: 8.	Output	Emission	N total	185.47			g	Water	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: The present concentrations are average values taken from different measurements and systems. Data basis are: a) Average half-hour-measurements of esternal analysis institutes. b) Average concentrations from on-line measurements. c) Internal company measurements and calculations. Notes: Off-gas emission data based on the Emission Declaration of Solvay (1996) according to the 11th directive of the BImSchV (German Immission Directice).	Output	Emission	NH3	58			g	Air	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Waste water data were calculated based on average measuring results of the official examinations carried out in 1999 at both Solvay Sosa Germany plant (Rheinberg) and Mathes & Weber plant (Duisburg). No. of measurements carried out at: Solvay Rheinberg: 21. Mathes & Weber: 8.	Output	Emission	Ni	1.09			g	Water	
Date concieved: 2003-03-17 Data type: Derived, mixed Represents: NO2 emissions (represented as NOx emissions) Method: The present concentrations are average values taken from different measurements and systems. Data basis	Output	Emission	NOx	193			g	Air	

are: a) Average half-hour-measurements of esternal analysis institutes. b) Average concentrations from on-line measurements. c) Internal company measurements and calculations. Notes: Off-gas emission data based on the Emission Declaration of Solvay (1996) according to the 11th directive of the BImSchV (German Immission Directice).									
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Waste water data were calculated based on average measuring results of the official examinations carried out in 1999 at both Solvay Sosa Germany plant (Rheinberg) and Mathes & Weber plant (Duisburg). No. of measurements carried out at: Solvay Rheinberg: 21. Mathes & Weber: 8.	Output	Emission	P total	52.1			g	Water	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: Waste water data were calculated based on average measuring results of the official examinations carried out in 1999 at both Solvay Sosa Germany plant (Rheinberg) and Mathes & Weber plant (Duisburg). No. of measurements carried out at: Solvay Rheinberg: 21. Mathes & Weber: 8.	Output	Emission	Pb	11.56			g	Water	
Date concieved: 2003-03-17 Data type: Derived, mixed Method: The present concentrations are average values taken from different measurements and systems. Data basis are: a) Average half-hour-measurements of esternal analysis institutes. b) Average concentrations from on-line measurements. c) Internal company measurements and calculations. Notes: Off-gas emission data based on the Emission Declaration of Solvay (1996) according to the 11th directive of the BImSchV (German Immission Directice).	Output	Emission	SO2	0.3			g	Air	
	Output	Product	Sodium carbonate	1			tonne	Technosphere	

About Inventory

Publication	Final Report ''German Notes on BAT for the Production of Large Volume Solid Inorganic Chemicals. Soda''. Institut für Umwelttechnik und Management and der Universität Witten/Herdercke, UBA, June 2001. --- Data inserted by: Jose Canga Rodrigues, Chalmers University of Technology and Akzo Nobel Surface Chemistry AB. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-05-28
Intended User	Chemical producing industry, L
General Purpose	The purpose is to estimate the emissions and raw materials needed for the production of sodium carbonate (Solvay Technique) on an average basis for Europe.
Detailed Purpose	To be included in LCA studies where sodium carbonate is used but no data from the supplier are available. This dataset was used in the Master of Science thesis work ''Life Cycle Assessment of Wood-Based Ethanol-Diesel Blends (E-Diesel). Jose Canga Rodrigues. Chalmers University of Technology and Akzo Nobel Surface Chemistry AB. Sweden. 2003. The aim of the study was to evaluate low ethanol-content diesel blends (E-diesel) used as automotive fuel.
Commissioner	- Akzo Nobel Surface Chemistry AB 444 85 Stenungsund Sweden.
Practitioner	Canga Rodríguez, José - Akzo Nobel Surface Chemistry S-44485 Stenungsund SWEDEN.
Reviewer	Manuilova, Anastassia - Akzo Nobel Surface Chemistry AB Enironmental Development S-44485 Stenungsund Sweden
Applicability	Applicable to Western European sodium carbonate suppliers, who produce soda following the Solvay Technique.

About Data	SODIUM CARBONATE PRODUCTION Data based on the average production of sodium carbonate in Germany and represent soda production in Western European countries. Data come from a study carried out by the German Environmental Agency. [UBA, 2001] ELECTRICITY Average electricity production in EU nations, namely Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Swedem and the United Kingdom. [DG XVII, 1999] REFERENCES ''Annual energy review'', Directorate General for Energy (DG XVII), 1999 Final Report ''German Notes on BAT for the Production of Large Volume Solid Inorganic Chemicals. Soda''. Institut für Umwelttechnik und Management and der Universität Witten/Herdercke, UBA, June 2001.
Notes	This data set was used in the Master of Science thesis work ''Life Cycle Assessment of Wood-Based Ethanol-Diesel Blends (E-Diesel). Jose Canga Rodrigues. Chalmers University of Technology and Akzo Nobel Surface Chemistry AB. Sweden. 2003.

SPINE LCI dataset: European Union, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	European Union, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	EU countries
Sector	Energyware
Owner	EU countries
Technical system description	The generation of electricity with different power generating systems in the European Union countries during the year 1998. The EU includes Austria, Belgium, Denmark, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	This scenario represents the average production of sodium carbonate in Germany.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Represents: Wind	Input	Refined resource	Electricity	11209			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	190762			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	191713			GWh	Technosphere	
Represents: Hydro power, pumped storage excluded	Input	Refined resource	Electricity	304583			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	366002			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	42098			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	4272			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas Notes: The value have been corrected after publishing. See Inventory Notes for a description.	Input	Refined resource	Electricity	501709			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	590			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	62			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	854182			GWh	Technosphere	
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	977			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	2468109			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -

Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	-- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 22 October 2001: <<< Changes made by Ann-Christin Pålsson, CPM: The electricity production by hard coal, coke oven and blast furnace gas have been corrected from 476575 GWh to 501709 GWh according to the original report. The error was identified and reported by Gunnar Mattson, ABB Corporate Research.

SPINE LCI dataset: Exterior coating (Swedish red paint) maintenance. ESA-DBP

Administrative	
Finished	Y
Date Completed	1999
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System

Name	Exterior coating (Swedish red paint) maintenance. ESA-DBP
Functional Unit	1 m2 * year
Functional Unit Explanation	1 m2 of Swedish red paint maintained over one year.
Process Type	Gate to gate
Site	Not applicable
Sector	Activities of households as employers
Owner	Not applicable
Technical system description	Maintenance of the exterior coating Swedish red paint. Data includes the production process, the manufacture and assembling of wooden cladding and painting, repainting and removal when necessary. This process is included in the system described in: Blanco-Rosete S. R., 2002, LCA data structure and time series related to construction and maintenance in Sweden. Environmental Systems Analysis report 2002:14, Chalmers University of Technology, Gothenburg, Sweden Other processes in the CPM Database also included in the above publication: Swedish red paint manufacturing and application. ESA-DBP Clay roof tile manufacturing. ESA-DBP Pine window production. ESA-DBP Floor maintenance. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	1999
Geographical Boundary	Sweden
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1999
Data Type	Unspecified
Represents	See 'Function'.
Method	Unknown.
Literature Reference	Häkkinen T, 1999, Environmental Impact of Coated Exterior Wooden Cladding. VTT Building Technology. Finland
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Light fuel oil				MJ	Technosphere	
	Input	Refined resource	Maintenance				kg	Technosphere	
	Output	Emission	Acetylene				kg	Air	
	Output	Emission	Alkanes				kg	Air	
	Output	Emission	Alkenes				kg	Air	
Notes: Aromates (C9-C10)	Output	Emission	Aromates				kg	Air	
	Output	Emission	Benzene				kg	Air	
	Output	Emission	CO				kg	Air	
	Output	Emission	CO2				kg	Air	
	Output	Emission	CO2				kg	Air	
	Output	Emission	Cu				kg	Air	
	Output	Emission	Ethane				kg	Air	
	Output	Emission	Ethene				kg	Air	

	Output	Emission	Formaldehyde				kg	Air	
	Output	Emission	HF				kg	Air	
	Output	Emission	Hg				kg	Air	
	Output	Emission	Methane				kg	Air	
	Output	Emission	NOx				kg	Air	
	Output	Emission	PAH				kg	Air	
	Output	Emission	Particles				kg	Air	
	Output	Emission	Propane				kg	Air	
	Output	Emission	Propene				kg	Air	
	Output	Emission	SO2				kg	Air	
	Output	Emission	TOC				kg	Water	
	Output	Emission	Toluene				kg	Air	
	Output	Emission	VOC				kg	Air	
	Output	Emission	Zn				kg	Air	
	Output	Product	Maintenance				m2 year	Technosphere	

About Inventory	
Publication	Blanco-Rosete S. R., 2002, LCA data structure and time series related to construction and maintenance in Sweden. Environmental Systems Analysis report 2002:14, Chalmers University of Technology, Gothenburg, Sweden
Intended User	LCA practitioners.
General Purpose	This process data set is recalculated to fit in the Master Thesis given in 'Publication'. Excerpt from the report (see 'Publication'): ''Construction, building maintenance and housing management contribute to a large extent to the environmental impact. When housing owners and managers perform their activities they should be aware of the environmental effects they cause. The environmental impact of existing houses could be addressed and diminished within the possibilities of a clever management.''
Detailed Purpose	Excerpt from the report (see 'Publication'): ''This master thesis descibes and defines a building system model for a multi-family house in Gothenburg over a 30 year period from 1970 to 2002 . The model was used to collect environmental impact information regarding materials or products used in the construction and maintenance of a building . The environmental impact ofa a multi-family house was evaluated through a Life Cycle Assessment (LCA). Finally to account the long sevice lifetime of a multi-family house two case studies were carried out to test if the use of Time series can illustrate the environmental impact of maintenance activities caused by decisionmaking in housing management.''
Commissioner	Not applicable - .
Practitioner	Sergio R. Blanco-Rosete - .
Reviewer	Birgit Brunklaus - Environmental Systems Analysis
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpt from the report (see 'Publication'): ''The results are originally presented for a 100 years time period and per square meter. When the calculations were performed the original data was modified to fit according to the funcional unit of this study.'' ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-09-21 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Extraction and beneficiation of rock phosphate

Administrative	
Finished	Y
Date Completed	99-01-25
Copyright	
Availability	Public

Technical System	
Name	Extraction and beneficiation of rock phosphate
Functional Unit	1 kg of commercial rock phosphate (32 % P2O5)
Functional Unit Explanation	
Process Type	Other
Site	
Sector	Metal and mineral mining
Owner	
Technical system description	Exactly what techniques the data represents in this dataset is uncertain as the data are average values from literature. No specific mining site has been studied. The text below gives generic information about extraction and beneficiation of rock phosphate. For further information on interpretations of what the data represent, see ''method'' in flow meta data window. Extraction of Rock Phosphate There are some 200 minerals containing more than 1 % of P2O5 (it is common to give the concentration of P in its fully oxidised form, P2O5), but the most important for the phosphoric acid industry are the apatite minerals of which the most commonly encountered are: Francolite - Ca10(PO4)6-x(CO3)x(F/OH)2+x Fluorapatite - Ca10(PO4)6(F/OH)2 There are two main types of apatite deposits: sedimentary and igneous. Fluorapatite predominates in igneous phosphate rock and francolite predominates in sedimentary phosphate rock (BAT N° 4, 1995). Sedimentary deposits are the most common origin for phosphate rock production. Both sedimentary and igneous rocks are associated with a large number of impurities. The largest sedimentary rock mining areas are found in Florida and Morocco, while igneous rock is mined in Russia (Kola), South Africa, Brazil and Finland. Compared to igneous rocks, sedimentary rocks contain more carbonates and fluorides and usually more aluminium and iron (Becker, 1989). Sedimentary rocks also contain a much higher amount of cadmium than igneous rocks do (Ullmann, vol. A 19, 1991). On the other hand, igneous rock normally has a lower P2O5 content. Therefore, mining of igneous rock uses larger mining area and produces more waste rock than mining of sedimentary rock does (Serviö pers. comm., 1998). Mining of phosphate rock is done either by open cast mining or underground mining. Approximately five tonnes of ore must be mined and beneficiated to produce one tonne of commercial phosphate rock with an average P2O5 content of 32 % (Ullmann, vol. A 19). Open cast mining consists of removing the overburden covering the phosphate bed and recovering the ore by mechanical shovels or by hydraulic methods. Economic conditions can allow up to 1.5-2 m3 of material to be removed per tonne reclaimed ore. When the overburden is too large under ground mining has to be chosen. This has been done in for example, Tunisia, Jordan and Egypt and for the igneous Kola rock in Russia (Becker, 1989). The mining, crushing and grinding of the phosphate ore are very energy intensive unit operations in rock phosphate processing. Size reduction is necessary because most mineral processing/separation methods require the ore to be of a certain size. Large quantities of energy are needed because most of the energy input is absorbed by the machine itself in vibration, generation of heat etc. and only part of the energy is available for breaking the rock. The energy required per unit mass increases rapidly as the desired particle size decreases. (Kirk-Othmer, vol. 16, 1995) Beneficiation of the Phosphate Ore Beneficiation or upgrading of the phosphate ore has called for a number of different techniques. In some favourable cases, only screening and drying is necessary to reach a commercial grade of about 30 % P2O5. However, in most cases the ore quality needs removal of impurities. For sedimentary rock, suitable techniques for economic ore concentration are crushing and screening or grinding, followed by pneumatic particle size selection and washing by hydrocyclones or classifiers. These techniques are based on particle size selection. The phosphate ore particles usually occur within particle size ranges between 60-80 mm and 1000-1400 mm (Becker, 1989).

	An ore concentration technique applied most often with igneous phosphate ore is flotation. It can be used when silica has to be removed from the ore. However, calcite ($CaCO_3$), a very frequent by-product from phosphate ore processing, is difficult to separate by flotation (Becker, 1989). Calcination (roasting) is another technique for the beneficication of phosphate ore. Although not frequently used it is sometimes selected to destroy calcite ($CaCO_3$). But even though CO_2 is released, CaO remains in the ore and is not easy to leach out by washing. Calcination also destroys organics and therefore prevents foaming in the later chemical rock treatment. Phosphate rock calcination usually reduces the original qualities of the ore in terms of phosphoric acid production (filtration rate). The changes, however, seem to affect the ore differently depending on the amount of CO_2 removed by the calcination. Consequently, rocks containing a large amount of CO_2 are more affected. (Becker, 1989) The process of mining and beneficiation to produce one ton of commercial rock phosphate (32 % P_2O_5) requires approximately 0.9 GJ/tonne rock or 2.9 GJ/tonne P_2O_5. If the rock is calcined the total energy requirement is doubled (Ullmann, vol. A 19, 1991). References: BAT N° 4 (1995). Production of Phosphoric Acid, Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry. EFMA - European Fertilizer Manufacturers' Association, Ave. E van Nieuwenhuyse 4, B-1160 Brussels, Belgium. Becker P (1989). Phosphates and Phosphoric Acid, Raw Materials, Technology and Economics of the Wet Process. Fertilizer Science and Technology Series-volume 6. Kirk-Othmer (1995). Encyclopedia of Chemical Technology, Volume 16, p.732-733. Ullmann's Encyclopedia of Industrial Chemistry (1991). Volume A 19. p. 448-455. Personal communication: Serviö H (1998). Kemira Chemicals OY, Siilinjärvi, Finland. Tel. +358 (0)10 862 6201.

System Boundaries

Nature Boundary	The system starts with extraction of rock phosphate and ends with commercial rock phosphate leaving the beneficiation site. Emissions and use of resources due to the production and combustion of steam and diesel are not included.
Time Boundary	The literature from which data are taken from is published in 1996 and 1998.
Geographical Boundary	Europe.
Other Boundaries	
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	There are two different types of origins for phosphate ore: igneous rock and sedimentary rock. The energy requirement for production of dry sedimentary phosphate rock is as low as 0.1 GJ/t rock phosphate (32 % P_2O_5) for the easiest rock to be upgraded. Mining of igneous rock requires higher energy consumption. As igneous rock is used to some extent for production of fertilisers in Western Europe the average number is assumed to be 0.9 GJ/t (Kongshaug, 1998). This figure correlates well with figures given by EFMA (1998) and Patyk (1996) and has also been chosen to be representative for production of fertilisers used in Western Europe. This value for energy consumption may be somewhat high when taking the considerable amount of import into account, since a large part of this import is of sedimentary origin. When it comes to partitioning the energy consumption between different energy sources, figures from Kongshaug (1998) and Patyk (1996) have been taken into account. According to Patyk (1996) there is a partition between the different energy sources diesel, steam and electricity for extraction of the rock phosphate used in Germany. This partition has been assessed to be representative for the rest of Western Europe as well. The resulting figures using the partitioning in Patyk (1996) and the total energy figure in Kongshaug (1998) are as follows; 0.23 GJ diesel/t rock phosphate, 0.47 GJ steam/t rock phosphate and 0.21 GJ electricity/t rock phosphate. Steam has been assumed to be produced by combustion of oil. Data for the amount of waste generated from producing rock phosphate is taken from EFMA (1998). Five tonnes of phosphate ore must be mined and benificiated to produce one tonne of commercial rock (32% P_2O_5).

Literature Reference	EFMA (1998). European Fertilizer Manufacturers' Association. Internet site: http://www.efma.org. Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. Patyk A (1996). International Conference on Application of Life Cycle Assessment in Agriculture, Food and Non-Food Agro Industry and Forestry: Achievements and Prospects. IFEU-Institut für Energie- und Umweltforschung Heidelberg; Wilkensstrasse 3, D-69120 Heidelberg, Germany.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Rock phosphate	5			kg	Ground	Europe
	Input	Refined resource	Diesel	0.23			MJ	Technosphere	Europe
	Input	Refined resource	Electricity	0.21			MJ	Technosphere	Europe
	Input	Refined resource	Steam	0.47			MJ	Technosphere	Europe
Notes: Commercial rock phosphate (32 % P2O5).	Output	Product	Rock phosphate	1			kg	Technosphere	Europe
	Output	Residue	Mineral waste	4			kg	Technosphere	Europe

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. --- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources for the production of fertilisers used in Sweden and Western Europe.
Detailed Purpose	The purpose was not to compare production of different fertilisers to each other but to generate a thorough inventory of emissions and use of resources due to the production of fertilisers used in Sweden and Western Europe. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems. Extraction and beneficiation of rock phosphate is one step in the line of production of fertilisers containing phosphorus.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	Applicable for extraction and beneficiation of rock phosphate in Europe. The data are intended to be used in life cycle assessments of fertiliser production. The dataset is included in aggregated datasets for production of fertilisers at Hydro Agri AB in Köping and in aggregated datasets for production of fertilsers used in Western Europe containing phosphorus (cradle to gate).
About Data	Data are gathered from literature, i.e. no specific extraction site has been studied.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Extraction and grinding of dolomite

Administrative

Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public (flow data are confidential and not included).

Technical System	
Name	Extraction and grinding of dolomite
Functional Unit	1 kg ground dolomite
Functional Unit Explanation	
Process Type	Other
Site	Sweden
Sector	Other mining
Owner	Sweden
Technical system description	The dolomite is extracted by open-pit mining demanding 5-10 times less energy than underground mining.

System Boundaries	
Nature Boundary	The system starts with extraction of dolomite and ends with ground dolomite leaving the factory gate. Emissions from production of electricity and production and combustion of diesel are not included.
Time Boundary	The figures were given in 1998.
Geographical Boundary	The extraction and grinding of dolomite takes place in Sweden.
Other Boundaries	Emissions and use of resources due to the production and combustion of diesel and production of electricity are not included in the system.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	There are two different types of origins for phosphate ore: igneous rock and sedimentary rock. The energy requirement for production of dry sedimentary phosphate rock is as low as 0.1 GJ/t rock phosphate (32 % P2O5) for the easiest rock to be upgraded. Mining of igneous rock requires higher energy consumption. As igneous rock is used to some extent for production of fertilisers in Western Europe the average number is assumed to be 0.9 GJ/t (Kongshaug, 1998). This figure correlates well with figures given by EFMA (1998) and Patyk (1996) and has also been chosen to be representative for production of fertilisers used in Western Europe. This value for energy consumption may be somewhat high when taking the considerable amount of import into account, since a large part of this import is of sedimentary origin. When it comes to partitioning the energy consumption between different energy sources, figures from Kongshaug (1998) and Patyk (1996) have been taken into account. According to Patyk (1996) there is a partition between the different energy sources diesel, steam and electricity for extraction of the rock phosphate used in Germany. This partition has been assessed to be representative for the rest of Western Europe as well. The resulting figures using the partitioning in Patyk (1996) and the total energy figure in Kongshaug (1998) are as follows; 0.23 GJ diesel/t rock phosphate, 0.47 GJ steam/t rock phosphate and 0.21 GJ electricity/t rock phosphate. Steam has been assumed to be produced by combustion of oil. Data for the amount of waste generated from producing rock phosphate is taken from EFMA (1998). Five tonnes of phosphate ore must be mined and benificiated to produce one tonne of commercial rock (32% P2O5).
Literature Reference	---
Notes	The figures are confidential and therefore not included.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Dolomite				kg	Ground	Sweden
Notes: Confidential.	Input	Refined resource	Diesel				MJ	Technosphere	Sweden
Notes: Confidential.	Input	Refined resource	Electricity				MJ	Technosphere	Sweden
Notes: Confidential.	Output	Emission	Particles				g	Air	Sweden
	Output	Product	Dolomite				kg	Technosphere	Sweden

About Inventory	
Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources for the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other but to generate a thorough inventory of emissions and use of resources due to the production of fertilisers used in Sweden. Extraction and grinding of dolomite is one step in the line of production of the fertilisers manufactured at Hydro Agri AB in Köping, Sweden. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	Data applicable for extraction and grinding of dolomite in Sweden (extraction by open-pit mining). This datset is included in aggregated datasets for fertiliser production at Hydro Agri AB in Köping (cradle to gate).
About Data	Data is given for a specific site in Sweden, i.e. the data are not taken from literature.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Extraction and processing of natural gas (NG). ESA-DBP

Administrative	
Finished	Y
Date Completed	1999
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Extraction and processing of natural gas (NG). ESA-DBP
Functional Unit	1 Nm3 processed natural gas
Functional Unit Explanation	Nm3 = normal cubic metre

Process Type	Cradle to gate
Site	Unknown
Sector	Fuel
Owner	Unknown
Technical system description	Extraction and processing of natural gas includes the extraction of natural gas from Danish oil and gas fields in the North Sea and natural gas processing in Nybro, Denmark. This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf Other processes in the CPM Database also included in the above publication: 'Unmodified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP' 'Unmodified natural gas vehicle (NGV) operating on CNG wiith 15 % hydrogen (HCNG-15). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on CNG wiith 15 % hydrogen (HCNG-15). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on CNG wiith 30 % hydrogen (HCNG-30). ESA-DBP'

System Boundaries

Nature Boundary	Extraction and processing of natural gas includes the extraction of natural gas from Danish oil and gas fields in the North Sea and natural gas processing in Nybro, Denmark.
Time Boundary	Data monitoring done in 1999.
Geographical Boundary	Extraction and processing of natural gas includes the extraction of natural gas from Danish oil and gas fields in the North Sea and natural gas processing in Nybro, Denmark.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1999
Data Type	Derived, mixed
Represents	See 'Function'.
Method	Derived from literature.
Literature Reference	Uppenberg S et al, 2001, Miljöfaktabok för bränslen. IVL rapport. Stockholm, Sweden, IVL Swedish Environmental Research Institute Ltd.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Hydro power	0.00677			MJ	Technosphere	
	Input	Resource	Coal	0.0461			MJ	Ground	North Sea
	Input	Resource	Crude oil	0.331			MJ	Ground	North Sea
	Input	Resource	Natural gas	2.3			MJ	Ground	North Sea
	Output	Emission	Benzene	0.068			g	Air	Denmark
	Output	Emission	CH4	0.48			g	Air	Denmark
	Output	Emission	CO2	172			g	Air	Denmark
	Output	Emission	HCFC-22	0.000002			g	Air	Denmark
	Output	Emission	HCl	0.000252			g	Air	Denmark
	Output	Emission	HF	0.00004			g	Air	Denmark
	Output	Emission	N2O	0.00392			g	Air	Denmark
	Output	Emission	NMVOC	0.104			g	Air	Denmark
	Output	Emission	NOx	0.8			g	Air	Denmark

	Output	Emission	Particles	0.0132			g	Air	Denmark
	Output	Emission	SOx	0.132			g	Air	Denmark
	Output	Residue	Hazardous waste	1.72			g	Technosphere	Denmark
	Output	Residue	Other waste	15.6			g	Technosphere	Denmark

About Inventory	
Publication	This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf
Intended User	LCA practitioners.
General Purpose	This data set is included in a master thesis. Excerpt from the master thesis abstract: ''Hydrogen is often considered as the way out of the environmental and economical problems associated with the use of fossil fuels. However, one of the main implementation barriers is the missing infrastructure. The introduction of hydrogen-blended compressed natural gas (HCNG) as a fuel for natural gas vehicles could serve as a bridging technology by using the existing natural gas infrastructure for the distribution of hydrogen.''
Detailed Purpose	Excerpt from the master thesis abstract: ''The purpose of this thesis is to assess and compare the environmental aspects of using natural gas, HCNG with 15% and 30% hydrogen by volume, and hydrogen as vehicle fuels within the scope of the proposed demonstration project.'' Excerpt from the report (see 'Publication'): ''Data for the production and distribution of natural gas is taken from the “Environmental factbook for fuels” (Uppenberg et al. 2001) published by the Swedish Environmental Research Institute (IVL). Their calculations are based on Sydkraft's LCA report “Environmental impact from Sydkraft's electricity production 1999” (Hansson et al. 2000), which is recommended by the IVL due to its high quality.''
Commissioner	Not applicable - .
Practitioner	Daniel Kilgus - .
Reviewer	Karl Jonasson -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-11-16 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Extraction of crude oil

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	

Technical System

Name	Extraction of crude oil
Functional Unit	1 kg
Functional Unit Explanation	1 kg crude oil.
Process Type	Cradle to gate
Site	North Sea
Sector	Crude oil and natural gas extraction
Owner	North Sea
Technical system description	The system includes extraction of crude oil in the North Sea. The extraction of crude follow the technique of tertiary extraction, where steam or carbon dioxide is injected in the oil reservoir to draw up the oil. The emissions to air consist predominantly of carbon dioxide and mostly derive from energy production on the platforms. The energy is used for operations such as transporting the oil ashure by pipeline and injecting wather and gas into the reservoirs. The rest of the emissions come from flaring of gas and some diffuse emissions. The emissions of oil to water comes from four sources: - The largest oil emission into water comes from the drilling mud during the actual drilling process. -From the reservoir a mixture of oil, gas and water comes. These are separated. The water is cleansed and then discharged into the sea. This water contains small amounts of oil. - In order to empty the tankers of oil, water is pumped in. When the water later on is discharged into the sea it contains small amounts of oil. - The last source consist of unforeseen oil emissions.

System Boundaries

Nature Boundary	Only the emissions to air and water are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	Energy consumption and the crude oil extracted are accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Unspecified
Represents	See 'Function'.
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992., where they have used data from the Norwegian Oil Direktorat in Stavanger. The data are based on production in the Norwegian sector and includes tertial extraction.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: The figure has been given by Röstein, Nordiska Oljedirektoratet, Stavanger Notes: Thermal energy	Input	Refined resource	Thermal energy	0.760			MJ	Technosphere	
Notes: Caused by the following: 5% flaring 20% Diffuse emissions 75% Energy production	Output	Emission	CO2	55.92			g	Air	

	Output	Emission	Oil	15.67			mg	Water	
	Output	Product	Crude oil	1			kg	Technosphere	

About Inventory

Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Ryden, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study of ''Packing and the Environment''.
Detailed Purpose	Exercise material in LCA coarse given at Technical Environmental Planning, at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data set is not very adequate if one wants to make a thorough assessment of crude oil extraction, because only a few parameters are accounted for.
About Data	
Notes	

SPINE LCI dataset: Extraction of crude oil and gas

Administrative

Finished	Y
Date Completed	1994
Copyright	Tapir Publishers
Availability	Public

Technical System

Name	Extraction of crude oil and gas
Functional Unit	1 Mega Tonne
Functional Unit Explanation	1 Mega Tonne produced crude oil and gas. 78,6% Crude oil and 21,3% gas.
Process Type	Cradle to gate
Site	Norway
Sector	Crude oil and natural gas extraction
Owner	Norway
Technical system description	The system involves extraction of offshore crude oil and (natural) gas in Norway and all Norwegian sites are included. The production therefore follows Norwegian standard concerning legislation and environmental policy. In the system the following operations are included: Production drilling, Well steam processing, Produced water removal, Pressure maintenance, Oil and gas metering, Flaring and venting, Power supply systems, Support and safety

systems and transportation of the crude oil and natural gas to the main land.

Below a more detailed description is given of the system.

PRODUCTION DRILLING

Drilling and casting of production wells

Production wells can be drilled either from the production platform, requiring the platform to be equipped with full drilling facilities of from a mobile production unit, which predrills platform wells and subsea completed wells. Current drilling technique enables the wells to be drilled with exact deviation any direction, even horizontally, from the drilling installation. This enables
several wells to be drilled from the same platform.

Drilling Equipment

The main equipment required for drilling a well are:
Drill string and bit
Well casting
Drilling derrick
Hoisting equipment
Blow-out preventer

The drill string is a heavy walled hollow pipe through which drilling fluids are pumped while the string rotates and turns the drill bit and maintains the pressure on the drill bit while it is cutting.

The well casting prevents the walls of the well from collapsing or leaking. When a new casting length is being drilled, the formation pressure is balanced by increasing the density of the drill fluid by adding barite (bariumsulphate), a heavy, insoluble salt. Handling the drill string and casting requires specialised heavy duty hoisting equipment which is provided by the drill tower (derrick).

The blowout preventor (BOP) is a safety device used during drilling and other well operations. Its main function is to ensure that the well can be shut down at any time. The BOP is an arrangement of independent valves that are placed on the top of the wallhead. The BOP can create a tight seal around the drill string in an emergency situation actually shear the drill string and close in the well.

Drilling a well can take from a few weeks to several months or even longer if complications should arise during the operations.

Drill Chemicals, Mud and Cutting Treatment System

The drill fluid has a number of functions and contains chemical components which:
Lubricates the drill string
Cools and cleans the drill bit
Balances the formation pressure
Stabilises the well bore and
Carries the drill cuttings out of the well

The composition of the drilling fluid is adjusted to meet changing needs as the well penetrates the various formations. A drilling fluid circulation system typically consists of a tank for mixing additives, circulation pump(s), and equipment for separating fluid and drill cuttings from the fluid returned from the well. Drilling conditions determines the type of cutting fluid to be used. It is common to divide the drilling fluids in two main groups; water based and oil based fluids.

A water miscible drilling fluid consists of a continuos water phase with dissolved salts, polymers, dispersed clay and a weighting material (such as barite).

The water immiscible drilling fluid is in general a water-in-oil emulsion with despersed clay and weighting material. Oil based drilling fluids have some operational advantages over water based fluids, because they need less chemical additives and create less drilling waste. While water based drilling fluids become increasingly contaminated during use, oil based drilling fluids only interact to a small extent with the drill cuttings and may therefore be recycled for reuse.

The rock-cuttings, from a well, contain traces of drilling fluids and chemicals. In the case of water based fluids, the cuttings are commonly discharged untreated to the sea. Oil contaminated cuttings are not permitted to be discharged to the sea. The oil-contaminated wastes are transported to shore for treatment and disposal. The oil contaminated fluid has a certain heat value and is often disposed of by thermal incineration. Reinjection of the drilling waste into a well for subsurface storage is being tested with promising result.

Well Completion

When the drilling of production well is finished, the well is then completed for production. The completion process includes the installation of a production string that carries the well fluid from the reservoir up to the processing facilities on the platform. An arrangement of valves often referred to as the Christmas tree, replaces the BOP on the top of the wall head. The Christmas tree can sit on either the platform deck in the case of a fixed platform of a subsea template.

WELL STEAM PROCESSING

Gas fields produce varying amounts of condensed hydrocarbons and water that have to be separated from the gas prior to export. Oil fields also contain some associated gas. Most of the oil fields on the Norwegian continental shelf also produce formation water. The amount of produced water normally increases as the oil reserves are depleted. Oil fields that are in the mature production stage may contain up to90% water in the produced steam.

The main reasons for oil and gas production are:
1. to separate the oil, gas and water to obtain an oil product with sufficiently low vapour pressure to enable oil transportation by pipeline using export pumps or direct offshore loading to a crude tanker.
2. to remove water and higher hydrocarbons from the gas phase to avoid multiphase flow conditions and hydrate formation.
3. to reduce water content for equipment corrosion protection
4. to meet gas and oil sales specifications

Several stages of oil and gas separation may be required depending on factors, such as:

composition of the well-steam
oil to gas ratio
requirements indicated by the type of export systems

As a result each field will have its own tailor made processing system. The processing system can be anything from a simple oil and gas separation to a complex multistage separation, dew point control and compression system.

All gas produced on the Norwegian continental sheft is exported by pipelines. Oil is either exported by pipelines or loaded directly into oil tankers on the field. In the latter case, a local storage facility is provided.

PRODUCED WATER REMOVAL

Separating the produced water from the oil is accomplished through a phase separation. The gas is normally dehydrated by triethylene glycol (TEG) in an absorption tower. The wet glycol is the regenerated in a heater before being recycled back to the absorption tower.

Produced Water Treatment System

After being separated from the oil/gas/water separators, the produced water is routed to a water cleaning system for removal of dispersed oil droplets before being discharged to sea. The treatment system removes most of the residual oil from the water. Several technologies are being used and technology improvements are gradually taking place. Separation in hydrocyclones is currently considered to be the most cost efficient technology for removing dispersed oil from produced water.

Some of the production chemicals added to the processing system, and many of the natural components dissolved in the produced water will be discharged to sea with the produced water.

PRESSURE MAINTENANCE

Some oil reservoirs maintain their pressure throughout the field production life due to natural water drive. On other oil fields the reservoir pressure declines as the field is depleted. Artificial pressure maintenance is possible on some of the fields by means of sea water or gas injection. Gas injection and seawater injection systems are installed on these fields.

High-pressure gas injection requires the gas to be injected into the gas cap of the oil reservoir through a dedicated injection well or an abandoned gas production well. Water injection wells are purpose-drilled. The injection medium, seawater is filtered in order to reduce the content of particles that may plug the reservoir formation. Dissolved oxygen is removed from the water in order to avoid corrosion, and chemicals are added to control scaling, algae and bacteria growth that may also plug the reservoir.

OIL AND GAS METERING

Fiscal measurements of the oil and gas production form the basis for income and tax revenues. Separate oil and gas metering systems are installed for every field.

FLARING AND VENTING

Facilities for flaring of the gas to depressurise the oil and gas processing facilities are installed as a safety precaution on all production platforms. The flare system consists of a pressure relief system and a flare tower or a long inclined boom. The boom provides protection from the heat and fire by increasing the distance between the flame and any other part of the installation.

Due to the lack of export facilities or a local gas market, flaring is still being used to burn off natural gas produced together with oil in some areas of the world. But in Norway flaring is only allowed when it is used for safety reasons. Some flaring may also occur during start-up, well operations, process upsets, blow-down and maintenance operations.

Small amounts of hydrocarbon gases are vented directly to the air from parts of the production processing line. There are several sources for these continuos and non-continuos emissions.

stripping gas from glycol regeneration
gas turbine start-up gas (on old platforms only)
venting, purge and blanket operations
fugitive emissions
compressor system seal leakage

The amount of gas venting is much lower on modern platforms than on the older ones.

POWER SUPPLY SYSTEMS

Gas turbines are used for power generation on production platforms, while diesel engines are used on mobile installations. Electrical cable connections from the hydropower-based Norwegian electricity grid are possible, and will be used for the first time on the Troll field with production start up planned for 1996. Diesel driven emergency power systems are installed on all manned installations.

Diesel fuel must be supplied from land while fuel gas supplies are taken directly from the gas produced by the platform.

SUPPORT AND SAFETY SYSTEMS

Production platforms are provided with all utility systems and functions to support the process and the platform operations. Safety systems are installed to meet the governmental safety regulations.

Support activities

Supply and Installation Services

Suppert activities are needed during all stages of production and transportation. These activities include passenger traffic, supply material, installations and services.

The consumable supplies range from personal goods as food and household articles to maintenance equipment. Drilling fluids and production chemicals are continuously being consumed. The supply vessels make regular trips to and from the operator’s onshore base. The operator normally contacts these vessels on a time charter basis. Supply vessels services are also available on the spot market.

Safety and Standby Vessels

To assist in case of unpredicted events such as blow-outs, platform accidents, man overboard accidents and other emergency situations, standby vessels are on service adjacent to the platform installation. In most emergency situations their assistance will be preliminary, rendering first aid, providing alternative communications and transportation possibilities. When additional help is required, ambulance helicopters and base-rescue take over. Every manned installation has a standby vessel in the immediate area.

Passenger Traffics and Helicopter Activities

Helicopter activities are divided into either onshore or offshore-based operations. The majority of the helicopters are based onshore and they transport personal to fixed and mobile offshore installations. Some helicopters are based offshore and these can be used for stand by service as well as internal traffic assignments and emergency search and rescue. There are permanent offshore-based helicopter bases at the Ekofisk, Statfjord and Frigg fields. The helicopters are also used for deliveries of urgent equipment or other special assignments.

Ship transport of personnel to the offshore facilities is not common practice in the Norwegian North Sea. Passenger transport to and from, offshore installations take place exclusively by helicopter.

TRANSPORTS OF CRUDE OIL AND NATURAL GAS

Transportation by Pipelines

There are a considerable number of oil and gas pipelines crisscrossing the North Sea bed. The pipelines can be categorised in two main groups.

1. oil and gas export pipelines going from the offshore fields to land -based receiving terminals.
2. infied pipelines transporting hydrocarbon fluids at various stages of processing between platforms and from sub sea installations to platforms.

Onshore pipelines are always buried while sub sea pipelines in many cases are left unburied. The large trunklines can resist heavy blows from trawler doors and other fishing gears and are generally only buried for short stretches in connection with landfalls. Pipelines are considered to have little impact on the local fishery since they are overtawlable.

Oil Shipment

Produced oil that is not being transported by pipelines is loaded from the platform installations via a loading buoy onto crude tankers. The majority of this is crude oil is unloaded at the Mongstad oil terminal in Western Norway, from where most of it is exported onward to markets in Europ and North America. The capability of the offshore loading crude tankers is about 100000 m3.

Offshore Loading Facilities
Previously offshore loading terminals were cylindrical steel tower with risers a rotating head, loading boom, a flexible transmission line and a helideck for standing equipment. A new type, which consists of a subsurface buoy with flexible risers/ transmission lines, is now installed on some fields. Flowlines convey production from the platform to the loading buoy over a distance of around 2 km. When a tanker arrives, the flexible transmission line is connected. The loading is then executed by pumping the oil from storage. The crude tankers are loading and unloading in a shuttle traffic manner. The total production is divided in production quotas according to the owner ship of the operating partnership companies. These companies may use different harbours usually within the North Sea Basin, and will have shipments delivered according to their production quotas.

System Boundaries

Nature Boundary	The environmental load taken account for are the substances emitted to air and sea, the resources used and the waste that is generated, when extracting and transporting the crude oil and gas. The following resource elements have been included: - Area, representing the surface area occupied by facilities or restricted for other use when the facility is in operation. - Energy, the energy is measured as the amount of fuel gas, diesel fuel and jet fuel consumed for power generation. Emissions to air cover the following: Combustion gases resulting from fuel gas, diesel and jet fuel based power and heat production, gas flaring, well test burning and incineration. Cold hydrocarbon vents and fugitive emissions. Escape of halon from five prevention systems. The emitted gases are comprised of CO_2, CO, NO_x, N_2O, CH_4, VOC, SO_2 and halon.The SO_2 emissions results from combustion of marine diesel fuel. The produced natural gas only contains traces of H_2S. AS a result the SO'' in the fuel gas exhaust is negligible. Small amounts of hydrocarbon gases are vented directly to the air from parts of the production processing line. There are several sources for these continuos and non-continuos emissions. stripping gas from glycol regeneration gas turbine start-up gas (on old platforms only) venting, purge and blanket operations fugitive emissions compressor system seal leakage The amount of gas venting is much lower on modern platforms than on the older ones. Emissions to water can be oil or other chemicals. The oil discharges can be either accidental spills or continuos planned discharges, such as oil dispersed in ballast water, discharged produced water and oil contained in discharged drilling fluids. The chemicals that are discharged are categorised in for different groups: - Drilling chemicals, which are discharged with the used drilling fluid. - Weighting materials, which is used in the drilling fluid to get sufficient fluid gravity. The weighting materials are discharged to sea with the drilling fluids. - Production chemicals, like corrosion inhibitors and biocides, are discharged with produced water, cooling water and dumped injection water. - Pipeline chemicals are corrosion inhibitors, methanol and glycol, which prevent hydrate formation in the pipelines. The chemicals are partly discharged to sea with the produced water.

Time Boundary	The development in gas and crude oil extraction is continuously progressing, and the data will therefore in time be out of date. The data are from 1991.
Geographical Boundary	Norway
Other Boundaries	The following waste is generated by the system The waste is classified in four different groups: - Hazardous waste, which is waste requiring special treatment, handling and disposal according to regulations - Household waste - Sewage - Industrial waste, which covers all the waste from production. Materials that are not recyclable are categorized as production waste. Not all the environmental load cased by the support activities are accounted for. Only emissions to air, material consumption and fuel consumption are summed up in the table. Things that are not accounted for are the drill strings used, chemical additives, food, supplies and the service of the supply base and home office. The construction of the equipment is not accounted for neither the energy consumption and emissions due to exploratory drilling.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	
Represents	Norwegian crude oil and gas
Method	The data are taken from Keiserås, Bakkane Kristin, Life cycle data for Norwegian oil and gas, 1994, Tapir publishers. Because the system, which the data represent, includes both the operation stage and the transportation stage, the values in the table are the sums of the values from table 6.2 and table 7.2 in Keiserås, Bakkane Kristin, Life cycle data for Norwegian oil and gas, 1994, Tapir publishers. All discharged to sea are based on aggregated data for the total Norwegian continental shelf. The data source for all oil discharges is the OLF Environmental Programme. Chemical discharge data are provided by the OLF. All emissions to air are estimated from aggregated data. Combustion gases are calculated by using standard emission factors for each emission gas. Data for fugitive emissions, consisting of CH4 and VOC are aggregated emission data from the total Norwegian continental shelf. The datasource is OLF environmental Programme Phase 2. Project C05: ''Direct Hydrocarbon Gas Emissions from Production and Riser Platforms'', Aker Engenering a.s. March 16th 1993.
Literature Reference	Keiserås Bakkene Kristin, Life cycle data for Norwegian oil and gas, 1994
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: The area includes fixed production units, mobile drilling units in operation, booster and comprimation stations and loading buoys.	Input	Natural resource	Mineral, oil and gas extraction area	0.41			km2	Ocean	Norway
Notes: Diesel and other marine fuels used in vessels and installations	Input	Refined resource	Diesel	3663			tonne	Technosphere	
	Input	Refined resource	Fuel gas	11000007.8			m3	Technosphere	
	Input	Refined resource	Jet fuel	123			tonne	Technosphere	
Notes: The amount of steel is defined as the total consumption of steel used in the production stage of extracting the oil and gas divided by lifetime, because the table shows the production of 1991. The life time is estimated to be 25 years.	Input	Refined resource	Steel	174			tonne	Technosphere	
	Output	Emission	CH4	86			tonne	Air	Norway
	Output	Emission	CO	83			tonne	Air	Norway
	Output	Emission	CO2	61248			tonne	Air	Norway
	Output	Emission	Drilling chemicals	235			tonne	Ocean	Norway

Method: Halon emissions are based on data from Statoil scaled up to cover all operations based on production volume.	Output	Emission	Halon	0.16			tonne	Air	Norway
	Output	Emission	N2O	1.36			tonne	Air	Norway
	Output	Emission	NOx	388			tonne	Air	
	Output	Emission	Oil discharges	10.32			tonne	Ocean	Norway
	Output	Emission	Oil spill	2.4			tonne	Ocean	Norway
	Output	Emission	Pipeline chemicals	0.0401			tonne	Ocean	Norway
	Output	Emission	Production chemicals	12			tonne	Ocean	Norway
	Output	Emission	SO2	8.96			tonne	Air	Norway
	Output	Emission	Weighting material	675			tonne	Ocean	Norway
	Output	Emission	VOC	817			tonne	Air	Norway
	Output	Product	Crude oil	786000			tonne	Technosphere	
	Output	Product	Gas	213000			tonne	Technosphere	
Method: Aggregated data for the total Norwegian oil and gas industry have been obtained from the waste receiving company Notes: Hazardous waste, is waste requiring special treatment, handling and disposal according to regulations	Output	Residue	Hazardous waste	315			tonne	Other	
Method: The household waste has been calculated using aggregated data from Statoil and scaled up.	Output	Residue	Household waste	265			tonne	Other	
Method: Industrial waste delivered to the onshore receiving plant. Data from Statoil are used and scaled up according to gas and oil production volume to cover the total industry. Scrap material on the sea floor collected through sea bottom surveys by NPD in 1992. Amounts for 1991 is assumed to equal quantities collected in 1992. Non -recycled parts of the facilities are recorded as industrial waste at the demobilisation stage, which is not part of this system. Notes: Industrial waste, covers all the waste from production. Materials that are not recycable are categorised as production waste.	Output	Residue	Industrial waste	74			tonne	Other	
Method: The total quantities of sewage are based on average per capita factors and split 25%on exploration and 75% on the production stage. Only the latter beeing part of this system.	Output	Residue	Sewage	6741			m3	Other	

About Inventory	
Publication	Keiserås, Bakkane Kristin, Life cycle data for Norwegian oil and gas, 1994, Tapir Publishers -- Data documented by: Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	
General Purpose	
Detailed Purpose	An attempt to clarify and assemble, unquantified and widely scattered information regarding Norwegian petrolium activities.
Commissioner	- .
Practitioner	Keiserås, Bakkane Kristin - Novatech a.s. P.O. Box 163 N-4033 Forus Norway.
Reviewer	
Applicability	The data are specific for offshore, by Norwegian standards extracted, crude oil and can therefore not with succsess be used for other countries oil production. Extraction of oil in Norway is internationally considered to be one of the most environmental

	friendly, because the oil companies have to follow strict environmental laws and therefore use the most advanced technology and equipment available on the market.
About Data	The data set includes all sites producing oil and natural gas in Norway.
Notes	

SPINE LCI dataset: Extraction of dolomite

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System	
Name	Extraction of dolomite
Functional Unit	1 kg
Functional Unit Explanation	1 kg dolomite.
Process Type	Cradle to gate
Site	Sweden
Sector	Mining and quarrying
Owner	Sweden
Technical system description	Extraction of dolomite.

System Boundaries	
Nature Boundary	The observed parameter is dolomite. No emission from the combustion of fossil fuels is included.
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are electricity and fossil fuel consumption. The extracted dolomite goes to the technosphere. No transports are included.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1991-01-01
Data Type	Unspecified
Represents	Norwegian crude oil and gas
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk

	i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Dolomite	1			kg	Ground	
Method: The amount 27 kWh/ton is recalculated to 0,0972 MJ/kg in the reference literature.	Input	Refined resource	Electricity	0.0972			MJ	Technosphere	
Notes: Assume diesel.	Input	Refined resource	Fossil fuel	0.634			MJ	Technosphere	
	Output	Product	Dolomite	1			kg	Technosphere	

About Inventory

Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and recycling of glass.
Detailed Purpose	To show the energy consumption for extraction of dolomite.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	
About Data	Fossil fuel is assumed to be diesel.
Notes	

SPINE LCI dataset: Extraction of dolomite

Administrative

Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public - flow data are confidential and not included.

Technical System

Name	Extraction of dolomite

Functional Unit	1 kg of commercial dolomite
Functional Unit Explanation	
Process Type	Other
Site	
Sector	Metal and mineral mining
Owner	
Technical system description	The dolomite is extracted by open-pit mining demanding 5-10 times less energy than underground mining.

System Boundaries

Nature Boundary	The system includes extraction of dolomite. Production and combustion of diesel are not included in the system.
Time Boundary	The data were given in 1998.
Geographical Boundary	The data are for extraction of dolomite in Sweden.
Other Boundaries	Emissions and use of resources due to the production and combustion of diesel are not included in the system.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	---
Notes	Confidential figures.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Confidential.	Input	Natural resource	Dolomite				kg	Ground	Sweden
Notes: Confidential.	Input	Refined resource	Diesel				MJ	Technosphere	Sweden
	Output	Product	Dolomite				kg	Technosphere	Sweden

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources for the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other but to generate a thorough inventory of emissions and use of resources for the production of fertilisers used in Sweden. Extraction of dolomite in Norway is one step in the line of production of the fertilisers manufactured at Hydro Agri AB in Landskrona, Sweden. The data

	are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	Data applicable for extraction of dolomite in Sweden (extraction by open-pit mining). This datset has been used in the aggregated system for production of CAN fertiliser (cradle to gate) at Hydro Agri AB in Landskrona representing extraction of dolomite in Norway.
About Data	Data are given for a specific site in Sweden, i.e. the data are not taken from literature.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Extraction of feldspar

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System	
Name	Extraction of feldspar
Functional Unit	1 kg
Functional Unit Explanation	1 kg feldspar.
Process Type	Cradle to gate
Site	
Sector	Mining and quarrying
Owner	
Technical system description	Extraction of feldspar.

System Boundaries	
Nature Boundary	The observed parameter is feldspar. No emission from the combustion of fossil fuel is included.
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are electricity and fossil fuel consumption The extracted feldspar goes to the technosphere. No transports are included.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991-01-01
Data Type	Unspecified, expert outspoke
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	Confidential figures.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Feldspar	1			kg	Ground	
Method: The amount 22 kWh/ton is recalculated to 0,0792 MJ/kg in the reference litterature.	Input	Refined resource	Electricity	0.0792			kg	Technosphere	
Method: The amount 132 kWh/ton is recalculated to 0,132 MJ/kg in the reference litterature. Notes: It is assumed to be diesel.	Input	Refined resource	Fossil fuel	0.132			kg	Technosphere	
	Output	Product	Feldspar	1			kg	Technosphere	

About Inventory

Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden --- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology ---
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and recycling of glass.
Detailed Purpose	To show the energy consumption for extraction of feldspar.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	
About Data	The fossil fuel is assumed to be diesel.
Notes	

SPINE LCI dataset: Extraction of lime

Administrative

Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System

Name	Extraction of lime
Functional Unit	1 kg
Functional Unit Explanation	1 kg lime
Process Type	Cradle to gate
Site	
Sector	Mining and quarrying
Owner	
Technical system description	Extraction of lime.

System Boundaries

Nature Boundary	The observed parameter is lime. No emission from combuston of fossil fuel is included.
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are the consumption of electricity and fossil fuel, but no emission from combuston is included. The extracted lime goes to the technosphere. No transports are included,
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991-01-01
Data Type	Unspecified
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	Confidential figures.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Lime	1			kg	Ground	
Notes: 0,0792 MJ/kg = 22 kWh/ton	Input	Refined resource	Electricity	0.0792			MJ	Technosphere	

Method: The amount 132 kWh/ton is recalculated to 0,132 MJ/kg in the reference literature. Notes: It is assumed to be diesel.	Input	Refined resource	Fossil fuel	0.132			MJ	Technosphere	
	Output	Product	Lime	1			kg	Technosphere	

About Inventory	
Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and use of glass.
Detailed Purpose	To show the energy consumption for extraction of lime.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	
About Data	The fossil fuel is assumed to be diesel.
Notes	

SPINE LCI dataset: Extraction of Portland soda

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System	
Name	Extraction of Portland soda
Functional Unit	1 kg
Functional Unit Explanation	1 kg Portland soda
Process Type	Cradle to gate
Site	
Sector	Mining and quarrying
Owner	
Technical system description	Extraction of Portland soda.

System Boundaries

Nature Boundary	The observed parameter is Portland soda. No emission from the combustion of diesel is included.
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are diesel consumption The extracted Portland soda goes to the technosphere. No transports are included.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991-01-01
Data Type	Unspecified
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	Confidential figures.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Portland soda	1			kg	Ground	
Method: The amount 5 kWh/ton is recalculated to 0,018 MJ/kg in the reference literature.	Input	Refined resource	Diesel	0.018			MJ	Technosphere	
	Output	Product	Portland soda	1			kg	Technosphere	

About Inventory

Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden --- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology ---
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and use of glass.
Detailed Purpose	To show the energy consumption for extraction of Portland soda.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	

Applicability	
About Data	
Notes	

SPINE LCI dataset: Extraction of sand

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System	
Name	Extraction of sand
Functional Unit	1kg
Functional Unit Explanation	1 kg sand.
Process Type	Cradle to gate
Site	
Sector	Mining and quarrying
Owner	
Technical system description	Extraction of sand.

System Boundaries	
Nature Boundary	The observed parameter is sand. No emission from the production of electricity is included
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are electricity consumption The extracted sand goes to the technosphere. No transports are included.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1991-01-01
Data Type	Unspecified
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk

	i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	Confidential figures.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Sand	1			kg	Ground	
Method: The amount 18-20 kWh/ton is recalculated to 0,0684 MJ/kg in the reference literature.	Input	Refined resource	Electricity	0.0684			MJ	Technosphere	
	Output	Product	Sand	1			kg	Technosphere	

About Inventory

Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and use of glass.
Detailed Purpose	To show the energy consumption for extraction of sand.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	
About Data	It is a 5% moisture content in sand.
Notes	

SPINE LCI dataset: Extraction of sulphur and production of sulphuric acid

Administrative

Finished	Y
Date Completed	99-01-25
Copyright	
Availability	Public

Technical System

Name	Extraction of sulphur and production of sulphuric acid
Functional Unit	1 kg of sulphuric acid (100 %)

Functional Unit Explanation	
Process Type	Other
Site	
Sector	Materials and components
Owner	
Technical system description	This dataset is intended to represent average values for production of sulphuric acid used in production of fertilisers used in Western Europe. Data have been taken from literature, no specific site has been studied. It has been assumed that 50 % of the sulphur used for production of sulphuric acid in the EU originates from the desulphurization of crude oil or natural gas, 30 % comes from other sulphides than pyrite and 20 % is derived from regeneration of waste acid. Further information on the method used to generate this dataset is given under ''method''. It is uncertain what exact techniques for production of sulphuric acid the data taken from literature represent. The text below gives generic information about extraction of sulphur and production of sulphuric acid. Sulphur is unusual compared to other minerals in that it is mainly used as a chemical reagent rather than as a component of a finished product. Sulphuric acid is the most common sulphur containing intermediate product and world-wide, well over half of the sulphuric acid is used in the manufacture of phosphorus and ammonium sulphate containing fertilisers (Kirk-Othmer, vol. 23, 1997). The most common sulphur sources are elemental sulphur from natural deposits (brimstone) and from desulphurization of natural gas or crude oil, sulphur dioxide from roasting of pyrites (FeS) and other metal sulphides, spent (contaminated or diluted) sulphuric acid, metal sulphate roasting and combustion of sulphur containing gases, such as hydrogen sulphide (H2S), carbon disulphide (CS2) and carbon sulphoxide (COS) (Kirk-Othmer, vol. 23, 1997; BAT N° 3, 1995). Elemental sulphur is by far the most widely used raw material for production of sulphuric acid (Kirk-Othmer, vol. 23, 1997). Extraction of Elemental Sulphur from Natural Deposits Ores containing native sulphur are found exclusively in the upper layer of the Earth's crust and are either of sedimentary origin or volcanic origin. Sulphur ores can be extracted either by normal open-pit or underground mining methods depending on the geology of the deposit. Under special geological conditions elemental sulphur is produced directly by fusion of hot water (Frasch process) (Ullmann, vol. A 25, 1994). The Frasch Process In some places where the geological structure is sedimentary, intrusion of rock salts from lower levels has distorted an overlying layer of anhydrite (calcium sulphate), dolomite (calcium-magnesium carbonate) and limestone (calcium carbonate) into dome-like structures. The anhydrite and the clays that lie over the limestone are impervious and the theory is that oil once accumulated in the more porous layer of limestone and dolomite. It is then thought that bacteria reduced the sulphate from the anhydrite to elementar sulphur and these bacteria are also thought to be responsible for the disappearance of oil in these accumulations. As a result the elemental sulphur is dispersed through the dolomite and limestone layers of the rock and the sulphur content varies from a few percent to 50 % (Ullmann, vol. A 25, 1994). The Frasch process involves injecting large quantities of hot water directly into the deposit, and thereafter pumping molten sulphur up to the surface. A well is drilled through the sulphur bearing layers down to the top of the underlying, impermeable anhydrite layer. Three coaxial pipes with different diameters are introduced into the borehole and pressurised water (2.5-3 MPa) at 165°C is forced down the annular space between the outer and the middle pipe. The water passes through perforations at the lower end of the outer pipe, since there is a collar that closes off the space between the two pipes about halfway down the perforations. The hot water penetrates into the cracks, pores and larger voids of the sulphur-bearing limestone, which results in melting of the sulphur. Since the density of sulphur is higher than the density of water, the sulphur collects at the bottom of the borehole. When a reservoir of molten sulphur has been established there, the water is turned off and the sulphur flows through the bottom openings, below the collar, of the outer pipe into the middle pipe. As sulphur has about 1.8 the density of water, it will only rise about halfway up the middle pipe under the influence of hydrostatic pressure. Hot compressed air is then injected through the innermost pipe. The resulting foam of sulphur and air is very light and rises easily the remaining distance to the surface. The sulphur is then transferred to a heated storage tank or solidified as slates, prills, pellets or pastilles. The extracted sulphur can be quite pure, 99.7-99.8 %, and light yellow in colour, but if it is contaminated by even small amounts of bituminous residues from the oil, it is brown or occasionally blackish in appearance. It is complicated to remove these impurities from the sulphur, but anyhow, the dark sulphur is acceptable for many uses (Ullmann, vol. A 25, 1994). Even though the Frasch process was originally developed to take advantage of the sulphur deposits in the area around the Gulf of Mexico, the technique has been further developed for use on less ideally structured deposits in Poland and Iraq (Ullmann, vol. A 25, 1994). The cost of energy is the greatest problem facing the Frasch process today. The required amount of hot water, which depends on the geological conditions at the bottom of the borehole, is the most important factor. Approximately 3-38 m3 of water at 165°C is required to produce one tonne of sulphur. In the aim of saving energy the Frasch process

could be combined with production of electricity which can be sold locally. Another possibility to save energy is the reuse of the hot injection water, but the problem is contamination of this water with, for example, hydrogen sulphide (Ullmann, vol. A 25, 1994).

Conventional Mining

All deposits, especially sedimentary ones, are not suitable for mining by Frasch techniques. In these cases conventional mining and benificiation techniques are utilised. Mining methods that have been practised include both surface open pit mining and subsurface tunnelling, room and pillar, cut and fill and various stoping systems (some of these mining methods are described in 10.4 potash salt). The choice of mining method is determined by the size, shape and depth of the ore deposit. High grade sulphur ores have often been roasted directly, but medium and low-grade sulphur ores have been beneficiated by the application of different techniques for sulphur recovery, such as flotation, melting, distillation, agglomeration and solvent extraction (Encyclopedia of Chemical Processing and Design, vol. 55, 1996).

Conventional mining and processing operations are normally more costly than Frasch operations for sulphur exploitation and are therefore normally employed only where political protection or other special local market conditions apply. Because of this Russia, Poland and China are the only countries that produce sulphur by conventional mining methods to a large extent today and this corresponds to 8 % of the global sulphur production (Encyclopedia of Chemical Processing and Design, vol. 55, 1996).

Desulphurization of Crude Oil and Natural Gas

Petroleum contains a variety of organic sulphur compounds, such as for example thiols, alkyl and aryl sulphides, thiophenes and more complex aromatic sulphur compounds. When crude oil is distilled at the refinery, the sulphur is partitioned between the various product fractions. Most of the sulphur is found in the heaviest fractions and in the residues. These were formerly used as industrial fuel, but since this contributed to atmospheric sulphur dioxide pollution, most industrial countries have now introduced regulations which limit the use of sulphur containing oil fractions as fuel. Therefore fuel oil has to be desulphurized at the refinery nowadays (Ullmann, vol. A 25, 1994).

Desulphurization of oil products can be achieved by reacting the sulphur components in the oil with hydrogen over a catalyst. The required pressure and temperature is dependent on the kind of oil that is desulphurized, e.g. heavy oil fractions require higher pressure than light oil fractions (Scanraff miljörapport, 1997). The resulting gas mixture is then pressurised, fed into an absorption tower and hydrogen sulphide is washed out by a circulating solution, e.g. amine, potassium carbonate, ether or glycol solution, in which it is either physically or chemically absorbed. Thereafter the solution is subjected to heat and depressurised and hydrogen sulphide is separated from the solution as the top product in a stripping tower. In the chemical solvent process the solution has to be stripped with steam, while in the physical solvent process much of the dissolved hydrogen sulphide comes out of the solution when the liquor is depressurised, i.e. less energy is required (Ullmann, vol. A 25, 1994).

Natural gas contains sulphur, mainly as hydrogen sulphide, and the proportions of sulphur vary widely. Some natural gas deposits contain no sulphur at all while the sulphur content can reach 30 % in others. Hydrogen sulphide must be removed before the natural gas is piped due to its toxicity. Therefore the gas must be processed at the wellhead. In such case, the separation of hydrogen sulphide is achieved in the same way as described above (Ullmann, vol. A 25, 1994).

Once it has been separated from other useful constituents of the gas mixture, hydrogen sulphide is normally converted into a more useful form of sulphur, e.g. elemental sulphur and sulphuric acid, since hydrogen sulphide is a very dangerous gas which has few industrial uses. The product choice is often elemental sulphur, which is cheaper and easier to transport than sulphuric acid (Ullmann, vol. A 25, 1994). The hydrogen sulphide gas is transferred to the sulphur recovery plant, often referred to as the Claus plant, which is divided into a combustion part and a reactor part. In the first part the hydrogen sulphide is partially combusted and elemental sulphur and sulphur dioxide are formed. The elemental sulphur is condensed and separated and the gas mixture of sulphur dioxide and hydrogen sulphide is led to the reactor part, which can consist of a various amount of reactors. The catalyst in the reactors is, for example, aluminium oxide and the formed elemental sulphur is condensed after each reactor (Ullmann, vol. A 25, 1994; Scanraff miljörapport, 1997). The concentration of sulphur dioxide and hydrogen sulphide in tail gas can be controlled by addition of air to the sulphur recovery plant. The recovery ratio of sulphur can be more than 99 % if the remaining sulphur dioxide in the tail gas is converted to hydrogen sulphide in an additional tail gas plant and the hydrogen sulphide thereafter is absorbed by a solution which is led back to the sulphur recovery plant (Scanraff miljörapport, 1997).

Extraction of Pyrite

The main deposits of pyrites are located in Spain and Portugal, but pyrite is also mined in Norway, Cyprus, Germany, Northern Italy and Russia (Ullmann, vol. A 25, 1994). In the absence of any elemental sulphur resources within the country, the use of pyrites as source of sulphur attains utmost importance. The main pyrite ore occurs in three distinct types, crystalline pyrite, shaly pyrite and amorphous pyrite (Prasad et al., 1994).

Production of sulphuric acid

Sulphuric acid results from the production of sulphur dioxide, its conversion into sulphur trioxide and finally, absorption of sulphur trioxide by water, giving sulphuric acid. These reactions are exothermic to various extent, except for the production of sulphur dioxide from metal sulphate roasting or regeneration of sulphuric acid, and, in the case of brimstone as raw material, 1.1 to 1.2 t steam is produced per tonne sulphuric acid. This steam can, for example, be used to produce electricity and to concentrate phosphoric acid in adjacent plants. Since there are many different sulphur raw materials, there are several ways of producing sulphur dioxide as well (UNEP, 1996). Thereafter, the production route is less dependent on the original sulphur source, even though there are several processes for the conversion and the absorption stage (BAT N° 3, 1995). Approximately 0.33 t brimstone, 0.76 t pyrite (48 % S) or 1.2t zinc ore is typical raw material input for the production of 1t sulphuric acid (100%) (UNEP, 1996).

Production of Sulphur Dioxide

Combustion of Sulphur
The elemental sulphur is first melted by heating to 135°C and the combustion is then carried out in a combustion unit at temperatures ranging from 900°C to 1800°C. The combustion unit consists of a combustion chamber followed by process gas cooler, since the reaction is strongly exothermic. The combustion gases are often diluted from around 18 % to 9 - 12 % sulphur dioxide by volume before entering the conversion process (BAT N° 3, 1995).

Roasting of Pyrite
Pyrite, or iron sulphide, is roasted in various types of furnaces, e.g. multiple-hearth furnace, rotary kiln and fluid bed roaster, producing a gas with a somewhat lower sulphur dioxide content than the combustion gases from burning elemental sulphur. This gas is then diluted to 8-10 % sulphur dioxide and treated in a high efficiency dust collector, e.g. electro-static dust collector, before conversion (BAT N° 3, 1995). The sulphur oxides is the main product and the iron oxides is the by-product (Patyk, 1996).

Other Metal Sulphide Roasting
Ores containing zinc, copper and lead sulphides are similarly roasted as iron sulphide in metallurgical processes, usually producing gases with even lower sulphur dioxide content (BAT N° 3, 1995). Here, the sulphur dioxide is a by-product and the metals are main products (Patyk, 1996).

Metal Sulphate Roasting
Metal sulphates, e.g. ferrous sulphates can be roasted, similarly as pyrite, using elemental sulphur and pyrites, but also coke, tar, lignite, coal and oil as both fuel and reductant. The content of sulphur dioxide in the combustion gases varies but is normally around 6-7 %. Large quantities of ferrous sulphate is obtained as the heptahydrate form (FeSO4*7H2O), during regeneration of pickling liquors or as a by-product in the titanium oxide process using the sulphate route. The heptahydrate is first dehydrated and the decomposed in a second stage (BAT N° 3, 1995).

Sulphuric Acid Regeneration
Regeneration of sulphuric acid is achieved by decomposition in a hot gas stream or a moving beds of solids, e.g. coke, sand or ore, at 800-1300°C. The produced gas contains 2-10 % sulphur dioxide, depending on the quality of spent acid. To compensate for quality, a complementary sulphur burner can be used to provide supplementary sulphur dioxide. The energy demand also vary with the quality of spent acid, rising steeply as acid concentration decreases and level of organic impurities increases and therefore a preceding concentration by evaporation to 60-75 % sulphuric acid often is energetically more favourable. The sulphur dioxide content is heavily diluted by the combustion gases and when using fuel oil, the acid concentration must be at least 60 % to obtain sufficient sulphur dioxide content for further processing in a double-contact sulphuric acid plant (BAT N° 3, 1995).

Combustion of Sulphur Containing Gases
The combustion of hydrogen sulphide (H2S), carbon sulphoxide (COS) and carbon disulphide (CS2) is carried out in a muffle furnace at 800-1200°C. The content of sulphur dioxide in the combustion gases is variable, between 0.5-12 % and depends on the raw material and processes used (BAT N° 3, 1995).

Production of Sulphur Trioxide
A catalyst, often containing alkali and vanadium oxides, is involved in the conversion of sulphur dioxide into sulphur trioxide (BAT N° 3, 1995). In case of roasting of metallic sulphides the sulphur dioxide containing combustion gases are first cleaned and dried, but if the sulphur dioxide is produced via sulphur burning, the air is dried before combustion (UNEP, 1996). If the oxygen concentration in the process gas is low after the combustion or roasting step, additional air or oxygen must be added prior to or during catalytic oxidation to ensure that there is an excess over stoichiometric needs for conversion of sulphur dioxide to sulphur trioxide. This reaction is highly exothermic and equilibrium becomes increasingly unfavourable for sulphur trioxide formation as temperature increases above 410-430°C. Unfortunately, this is the minimum temperature level required for typical commercial catalysts to function. As a result, plant catalytic converters are typically designed as multistage adiabatic units with gas cooling between each stage (Kirk-Othmer, vol. A 23, 1997).

Production of Sulphuric Acid

Single Contact Process
In single contact plants, sulphuric trioxide is absorbed at the end of the process. Nowadays, this process is only used in new plants when the sulphur dioxide content of the combustion gas is low and widely varying (UNEP, 1996). After the conversion step the sulphur trioxide is absorbed in sulphuric acid in absorbers where it is converted to sulphuric acid by the water in the sulphuric acid. The absorbing acid is kept at the constant desired concentration of

approximately 99 % by the addition of water or dilute sulphuric acid. If the concentration of sulphur dioxide in the combustion gas is between 6 and 10 %, the conversion efficiency is about 98 %. It is difficult to obtain more than 98.0 % in existing plants. The conversion ratio is somewhat lower if the concentration of sulphur dioxide in the combustion gas is less then 6 % (BAT N° 3, 1995).

Double Contact Process
In the early 1970s, air pollution problems led to the adoption of the double contact process or double absorption process (Kirk-Othmer, vol. 23). In this process there is a primary converter followed by an intermediate absorber, a secondary converter and a final absorber. The absorption of sulphur trioxide in the intermediate absorber shifts the equilibrium towards the formation of sulphur trioxide in the residual gas, resulting in an overall conversion efficiency of at least 99.6 % in case of sulphur burning. Feed gases containing 9-12 % sulphur dioxide is generally used for this process (BAT N° 3, 1995).

Pressure Contact Process
The oxidation of sulphur dioxide is favoured by high pressure and therefore, pressure contact processes has been developed. In these processes the sulphur dioxide conversion and the sulphur trioxide absorption are both carried out at high pressure. Even higher conversion ratio, 99.80-99.85 % is reported for this type of process. On the other hand, the temperature in the sulphur furnace is higher than the double contact process, which increases the nitrogen oxide formation. The process also consumes more power and produces less steam than the conventional double-contact process. The process is not new but so far, it has only been employed in one industrial double-absorption plant in France (BAT N° 3, 1995).

Wet Contact Process
Contrarily to the conventional contact processes in which dry mixtures of sulphur dioxide and air are treated, wet gas is used in the wet gas process. This process has been employed to treat off-gases containing at least 10% hydrogen sulphide from cookeries, mineral oil refineries, fuel gasification or low-temperature carbonisation plants, natural gas cleaning installations, carbon bisulphide production plants and synthetic fibre plants. The hydrogen sulphide in the treated off-gas is first burnt to sulphur dioxide and water (steam) and the sulphur dioxide is then converted to sulphur trioxide which together with the formed steam yields sulphuric acid. The concentration of the produced acid is between 78 and 93 %. Gases with a lower hydrogen sulphide content than 10% have to be burnt by additional heating, e.g. fuel gas, oil or sulphur (UNEP, 1996). The conversion efficiency, regarding sulphur dioxide, of the Wet Contact Process is normally about 95-98 % (BAT N° 3, 1995).

Other Processes
The Modified Lead Chamber process is able to treat gases with a low content of sulphur dioxide, 0.5-8 %, but also gases containing a mixture of sulphur dioxide and nitrogen oxides. The nitrogen oxides are used to promote acid production directly from sulphur dioxide. The process is potentially useful for cleaning the off-gases from power plants and ore roasting plants. The conversion efficiency is almost 100% for sulphur dioxide contents between 0.5 and 8 % but emissions of nitrogen oxides occur to relatively high extent (BAT N° 3, 1995).

There is also a process in which hydrogen peroxide is used to convert sulphur dioxide to sulphur trioxide. The efficiency is higher than 99 % and no waste is generated but the cost for hydrogen peroxide makes this process uneconomic for sulphuric acid production, unless emissions lower than those of the double contact process are required (BAT N° 3, 1995).

The most recent and rather radical development in sulphuric acid technology has taken place in Russia. A process in which the gas flow is periodically reversed over a single-bed converter has been reported. It is claimed that this process permits the treatment of gases of low and variable concentrations of sulphur dioxide, without the need for much of the expensive heat exchange equipment associated with other processes (BAT N° 3, 1995).

References:
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UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France.

System Boundaries

Nature Boundary	The system starts with extraction of sulphur and ends with sulphuric acid leaving the factory gate. Emissions from production of steam are not included. Emissions and consumption of energy and resources due to the production and disposal of catalysts used in the sulphuric acid process are not included. However, this is assumed to be of minor importance since the catalyst material often is recycled to a large extent.
Time Boundary	The literature from which data are taken from is published in 1996 and 1998.
Geographical Boundary	Europe.
Other Boundaries	
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	According to Patyk (1996) 50 % of the sulphur used for production of sulphuric acid in the EU originates from the desulphurization of crude oil or natural gas, 30 % comes from other sulphides than pyrite and 20 % is derived from regeneration of waste acid. Elemental sulphur from desulphurization of crude oil or natural gas is not linked to any energy consumption since the sulphur here is regarded as a by-product, but the net export of energy in form of steam from the production of sulphuric acid is around 3.6 GJ/t H2SO4. The net export of steam from the production of sulphuric acid from sulphides is approximately 0.98 GJ/t H2SO4 and production of sulphuric acid using waste acid as raw material consumes about 5 GJ steam/t H2SO4 (Patyk, 1996). This leads to a balancing value for consumption of steam of -1.1 GJ/t H2SO4, which implies a net export of steam. This value has been assessed to be relevant as an average value for the production of sulphuric aid used in Western Europe, when taking data from Kongshaug (1998) into account. Concerning emissions of sulphur dioxide (SO2) and sulphur trioxide (SO3), the figures 5 kg SO2/t H2SO4 and 0.3 kg SO3/t H2SO4 have been chosen as representative values for production of sulphuric acid used in Western Europe. See also ''specific QMetaData''. Emissions and consumption of energy and resources due to the production and disposal of catalysts used in the sulphuric acid process are not included. However, this is assumed to be of minor importance since the catalyst material often is recycled to a large extent.
Literature Reference	Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. Patyk A (1996). International Conference on Application of Life Cycle Assessment in Agriculture, Food and Non-Food Agro Industry and Forestry: Achievements and Prospects. IFEU-Institut für Energie- und Umweltforschung Heidelberg; Wilkensstrasse 3, D-69120 Heidelberg, Germany. UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France.
Notes	Confidential figures.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: From sulphides.	Input	Natural resource	Sulphur	0.0982			kg	Ground	
	Input	Refined resource	Steam	-1.09			MJ	Technosphere	Europe
Notes: From waste acid.	Input	Refined resource	Sulphur	0.0654			kg	Technosphere	
Notes: Claus process.	Input	Refined resource	Sulphur	0.164			kg	Technosphere	Europe
Notes: This figure is an average between emission from a single contact plant (10-12 g SO2/kg H2SO4) and emission from a new double contact plant (2-3 g SO2/kg H2SO4). An assumed value by the practitioners (UNEP, 1996).	Output	Emission	SO2	5			g	Air	Europe

Notes: This figure is an average between emission from an existing plant (0,6 g SO3/kg H2SO4) and emission from a new double contact plant (0,15 g SO3/kg H2SO4) given by UNEP (1996). An assumed value by the practitioners.	Output	Emission	SO3	0.3			g	Air	Europe
	Output	Product	H2SO4	1			kg	Technosphere	Europe

About Inventory	
Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources for the production of fertilisers used in Sweden and Western Europe.
Detailed Purpose	The purpose was not to compare production of different fertilisers with each other but to generate a thorough inventory of emissions and use of resources due to the production of fertilisers used in Sweden and Western Europe. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems. Production of sulphuric acid is one step in the line of production of fertilisers containing phosphorus.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The data are intended to be used as input information for the production of phosphoric acid that is used in production of fertilisers used in Western Europe. The dataset is included in aggregated datasets for production of fertilisers containing phosphorus used in Western Europe (cardle to gate).
About Data	The only emissions taken into account are emissions of SO2 and SO3 due to lack of information. All data are taken from literature, no specific site has been studied.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedsih Institute for Food and Biotechnology).

SPINE LCI dataset: Extraction to ABS APME

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Extraction to ABS APME
Functional Unit	1 kg of ABS (acrylonitrile-butadiene-styrene copolymer)
Functional Unit Explanation	According to the schematic flow diagram in the ''Eco-profiles...'' report, the product is a mixture (weighted average?) of mass polymerised ABS copolymer and compounded ABS copolymer. ABS is a two-phase polymer consisting of a glassy matrix of a copolymer of styrene (C6H5-

	CH=CH2) and acrylonitrile (CH2=CH-CN), and the synthetic rubber copolymer of styrene and butadiene (CH2=CH-CH=CH2). The glassy and rubbery phases are grafted in a suitable way. ABS copolymers are engineering polymers with good toughness, temperature stability and solvent resistance properties. They can be formed using all of the common plastics techniques and can also be cold formed using techniques associated with metals. Typical uses of ABS: interior and exterior automotive parts, housings for domestic appliances such as hair driers and vacuum cleaners, kitchen appliances such as refrigerator linings and mixing machines, furniture parts, telephones, toys, pipes and profiles.
Process Type	Cradle to gate
Site	European average values, Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average values, Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	Production of ABS (acrylonitrile-butadiene-styrene copolymer) including all major operations from extraction of crude oil and gas to polymerisation and compounding. According to a schematic flow diagram in the ''Eco-profiles...'' report, the following sub-processes are included: - Cracking of naphtha and/or natural gas for ethylene, propylene and butenes. - Styrene production: Reforming of naphtha for benzene + production of benzene from cracking products (''pygas'') in an aromatics plant, ethylene from cracker, ethylbenzene production, styrene production. - Acrylonitrile production: Propylene from cracker, production of ammonia from natural gas and air, production of acrylonitrile from ammonia and propylene. - Polybutadiene production: Butenes + butadiene from cracker, dehydrogenation of butenes to butadiene, polymerisation of butadiene. - ABS mass polymerisation. - ABS graft copolymer production. - ABS polymerisation. - Compounding. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and delivery; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been traced back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 5 plants in 3 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. Some more information about the processes are found in the ''Eco-profiles...'' reports for ABS (acrylonitrile-butadiene-styrene copolymer), naphtha and the other intermediates, and the Methodology report, which are available at APME''s web site http://lca.apme.org.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available.'' Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under their specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment. Emissions <0.5 mg were presented as <1 mg in the Eco-profiles result tables. In this activity, however, they are presented as 0.25 mg (1/2 of the maximum value 0.5 mg). Note that the actual values may be far below 0.5 mg in some cases. The energy resources Hydrogen and Sulphur have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table.
Time Boundary	Data refer to the year 1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data for 5 ABS production plants that produced 360 000 tonnes (unknown fraction of the total European production). Data were supplied by 5 plants in 3 countries: Germany, Italy and Netherlands. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates. For the intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides that plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included.) - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most other cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0.01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Methodology report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g., sulphuric acid is used as a drying agent for chlorine; therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of

	chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity.
Systems Expansions	Not applied. The amount of Recovered energy is reported as a negative primary energy equivalent input.

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, mixed
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	European average data. Results are based on data supplied by 5 ABS production plants in 3 countries: Germany, Italy and Netherlands. Their total production was 360 000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. Emissions and resources <0.5 mg have been assumed by Gunnar Mattson, ABB Corporate Research (GM) to be 0.25 mg, i.e. half the ''<'' values given, which is in accordance with common statistical procedure. The energy resources Hydrogen (0.10 MJ) and Sulphur (0.06 MJ) have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table.
Literature Reference	''Eco-profiles of the European plastics industry'', report for ABS (acrylonitrile-butadiene-styrene copolymer), naphtha and the other intermediates. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe)
Notes	In the result tables in the ''Eco-profiles...'' report, not only total fuels and feedstocks, emissions to air and water, and solid waste are presented, but also the amounts caused by fuel production, fuel use, transport, feedstock (only for fuels and feedstocks) and processes. As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field. Please note: Some other interpretations/changes have been made from the original report by Gunnar Mattson, ABB Corporate Research. See Method and AboutData for details.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: ''air'', compressed air	Input	Natural resource	Air	300			g	Ground	
Notes: ''barytes''	Input	Natural resource	Barytes	2			mg	Ground	
Notes: ''bauxite''	Input	Natural resource	Bauxite	600			mg	Ground	
Notes: ''bentonite''	Input	Natural resource	Bentonite	200			mg	Ground	
Notes: ''Biomass''	Input	Natural resource	Biomass	1			g	Ground	
Notes: ''calcium sulphate''	Input	Natural resource	CaSO4	98			mg	Ground	
Notes: ''chalk'', <0.5 mg	Input	Natural resource	Chalk	0.25			mg	Ground	
Notes: ''chromium'', <0.5 mg	Input	Natural resource	Chromium in ore	0.25			mg	Ground	
Notes: ''clay''	Input	Natural resource	Clay	16			mg	Ground	

Notes: ''Crude oil'', gross primary fuel and/or feedstock resource, 770 g or 34.6 MJ.	Input	Natural resource	Crude oil	770			g	Ground	
Notes: ''dolomite''	Input	Natural resource	Dolomite	10			mg	Ground	
Notes: ''feldspar'', <0.5 mg	Input	Natural resource	Feldspar	0.25			mg	Ground	
Notes: ''fluorspar''	Input	Natural resource	Fluorspar	4			mg	Ground	
Notes: ''granite'', <0.5 mg	Input	Natural resource	Granite	0.25			mg	Ground	
Notes: ''gravel''	Input	Natural resource	Gravel	8.5			g	Ground	
Notes: ''Coal'', gross primary fuel and/or feedstock resource, 150 g or 4.11 MJ. 330 mg ''Metallurgical coal'' is included.	Input	Natural resource	Hard coal	150			g	Ground	
Notes: ''Hydro'', gross primary energy equivalent (80% electricity production efficiency has been assumed in APME reports).	Input	Natural resource	Hydro energy	0.18			MJ	Ground	
Notes: ''iron''	Input	Natural resource	Iron in ore	890			mg	Ground	
Notes: ''potassium chloride''	Input	Natural resource	KCl	4.5			g	Ground	
Notes: ''lead''	Input	Natural resource	Lead in ore	1			mg	Ground	
Notes: ''Lignite'', gross primary fuel and/or feedstock resource, 110 g or 1.65 MJ.	Input	Natural resource	Lignite	110			g	Ground	
Notes: ''limestone''	Input	Natural resource	Limestone	18			g	Ground	
Notes: ''magnesium''	Input	Natural resource	Magnesium in ore	1.2			g	Ground	
Method: ''ferromanganese'', 1 mg. It was assumed by SECRC/GM that the ferromanganese contained 80% Mn. Notes: ''ferromanganese''	Input	Natural resource	Manganese in ore	0.8			mg	Ground	
Notes: ''nitrogen''	Input	Natural resource	N2	310			g	Ground	
Notes: ''sodium chloride''	Input	Natural resource	NaCl	6.2			g	Ground	
Notes: ''Gas/condensate'' (natural gas), gross primary fuel and/or feedstock resource, 1100 g or 57.0 MJ.	Input	Natural resource	Natural gas	1.1			kg	Ground	
Notes: ''nickel'', <0.5 mg	Input	Natural resource	Nickel in ore	0.25			mg	Ground	
Notes: ''oxygen''	Input	Natural resource	O2	41			mg	Ground	
Notes: ''olivine''	Input	Natural resource	Olivine	8			mg	Ground	
Notes: ''Peat''	Input	Natural resource	Peat	15			mg	Ground	
Method: ''phosphate as P2O5'', <0.5 mg, which corresponds to <0.2 mg P (44% P in P2O5). Notes: ''phosphate as P2O5''	Input	Natural resource	Phosphorus in ore	0.11			mg	Ground	
Notes: ''sand''	Input	Natural resource	Sand	600			mg	Ground	
Notes: ''shale''	Input	Natural resource	Shale	280			mg	Ground	
Notes: ''sulphur (bonded)'', 3.1 g + ''sulphur (elemental)'', 6.2 g	Input	Natural resource	Sulphur in ore	9.3			g	Ground	
Notes: ''talc''	Input	Natural resource	Talc	21			g	Ground	
Method: ''rutile'', <0.5 mg, which should correspond to <0.3 mg Ti, assuming that the rutile (TiO2) mineral contained 60% Ti. Notes: ''rutile''	Input	Natural resource	Titanium in ore	0.15			mg	Ground	
Notes: ''Unspecified'', gross primary fuel and/or feedstock	Input	Natural resource	Unspecified energy	0.28			MJ	Ground	
Data type: Derived, mixed Method: ''Nuclear'' energy, 1.84 MJ, gross primary energy equivalent (35% electricity production efficiency has	Input	Natural resource	Uranium in ore	5.06			mg	Ground	

been assumed in APME reports). 35% efficiency [1] and 7.85 mg uranium resource/MJ electricity [2] are assumed by SECRC/GM, i.e. 1.84 MJ Nuclear energy should correspond to 1.84*0.35*7.85=5.06 mg of natural uranium (U) resource. 2001-06-18 SECRC/GM Literature: [1] ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. [2] ''Oekoinventare von Energiesystemen'', R. Frischknecht & al, ETH, 1996.									
Notes: ''Gross water resources'', total. Aggregation of different sources: ''Public supply'', 6.4 kg ''River/canal'', 46 kg ''Sea'', 105 kg ''Unspecified'', 17 kg ''Well'', 250 g 9.3 kg of the water is used for processing, 165 kg for cooling.	Input	Natural resource	Water	174			kg	Ground	
Notes: ''Wood''	Input	Natural resource	Wood	1.3			g	Ground	
Notes: ''zinc'', <0.5 mg	Input	Natural resource	Zinc in ore	0.25			mg	Ground	
Notes: ''Recovered energy'', gross primary energy equivalent	Input	Refined resource	Recovered energy	-4.86			MJ	Technosphere	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Water	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Air	
Notes: ''Acid (H+)''	Output	Emission	Acid as H+	45			mg	Water	
Notes: ''Al+++''	Output	Emission	Al	98			mg	Water	
Notes: ''Aldehydes (CHO)'', unspecified, <0.5 mg	Output	Emission	Aldehydes	0.25			mg	Air	
Notes: ''Aromatic-HC'', unspecified	Output	Emission	Aromatics	450			mg	Air	
Notes: ''Arsenic'', <0.5 mg	Output	Emission	As	0.25			mg	Water	
Notes: ''BOD'', biochemical oxygen demand	Output	Emission	BOD	33			mg	Water	
Notes: ''Ca++''	Output	Emission	Ca	260			mg	Water	
Notes: ''CFC/HCFC'', unspecified	Output	Emission	CFCs/HCFCs	1			mg	Air	
Notes: ''Organo-Cl'', unspecified, <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Air	
Notes: ''Organo-chlorine'', <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Water	
Notes: ''Cl-''	Output	Emission	Cl-	4.5			g	Water	
Notes: ''Cl2'', <0.5 mg	Output	Emission	Cl2	0.25			mg	Air	
Notes: ''Dissolved Cl2'', <0.5 mg	Output	Emission	Cl2	0.25			mg	Water	
Notes: ''CN-''	Output	Emission	CN-	9			mg	Water	
Notes: ''CO''	Output	Emission	CO	3.8			g	Air	
Method: CO2, unlike other emissions, is not measured but calculated from the amounts of combusted fuels. The amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes. CO2 emission from use of biomass has been subtracted from the total. Notes: ''CO2''	Output	Emission	CO2	3.1			kg	Air	
Notes: ''CO3--''	Output	Emission	CO32-	180			mg	Water	
Notes: ''COD'', chemical oxygen demand	Output	Emission	COD	2.2			g	Water	
Notes: ''CrO3'', <0.5 mg, which corresponds to <0.26 mg Cr(VI), as there is 52% Cr in CrO3.	Output	Emission	Cr(VI)	0.13			mg	Water	
Notes: ''CS2'', <0.5 mg	Output	Emission	CS2	0.25			mg	Air	
Notes: ''Cu+/Cu++'', <0.5 mg	Output	Emission	Cu	0.25			mg	Water	
Notes: ''Dissolved organics'', unspecified	Output	Emission	Dissolved organics	32			mg	Water	
Notes: ''Dissolved solids'', unspecified	Output	Emission	Dissolved solids	1.1			g	Water	
Notes: ''F-'', <0.5 mg	Output	Emission	F-	0.25			mg	Water	

Notes: ''F2''	Output	Emission	F2	1			mg	Air	
Notes: ''Fe++/Fe+++'', <0.5 mg	Output	Emission	Fe	0.25			mg	Water	
Notes: ''Hydrogen (H2)''	Output	Emission	H2	79			mg	Air	
Notes: ''H2S''	Output	Emission	H2S	1			mg	Air	
Notes: ''H2SO4'', <0.5 mg	Output	Emission	H2SO4	0.25			mg	Air	
Notes: ''HCl''	Output	Emission	HCl	70			mg	Air	
Notes: ''HCN'', <0.5 mg	Output	Emission	HCN	0.25			mg	Air	
Notes: ''HF''	Output	Emission	HF	3			mg	Air	
Notes: ''Hg'', <0.5 mg	Output	Emission	Hg	0.25			mg	Water	
Notes: ''Mercury (Hg)'', <0.5 mg	Output	Emission	Hg	0.25			mg	Air	
Notes: ''Hydrocarbons'', unspecified	Output	Emission	Hydrocarbons	4.1			g	Air	
Notes: ''Hydrocarbons'', unspecified	Output	Emission	Hydrocarbons	68			mg	Water	
Notes: ''K+''	Output	Emission	K	140			mg	Water	
Notes: ''Metals'', unspecified	Output	Emission	Metals	4			mg	Air	
Notes: ''Metals - unspecified''	Output	Emission	Metals	410			mg	Water	
Notes: ''Methane''	Output	Emission	Methane	10			g	Air	
Notes: ''Mg++''	Output	Emission	Mg	970			mg	Water	
Notes: ''Other nitrogen''	Output	Emission	N total	100			mg	Water	
Notes: ''N2O'', <0.5 mg	Output	Emission	N2O	0.25			mg	Air	
Notes: ''Na+''	Output	Emission	Na	1.1			g	Water	
Notes: ''Ammonia (NH3)''	Output	Emission	NH3	2			mg	Air	
Notes: ''NH4''	Output	Emission	NH4+	340			mg	Water	
Notes: ''Ni++'', <0.5 mg	Output	Emission	Ni	0.25			mg	Water	
Notes: ''NO3-''	Output	Emission	NO3-	71			mg	Water	
Notes: ''NOx''	Output	Emission	NOx	11			g	Air	
Notes: ''Detergent/oil'', unspecified	Output	Emission	Oil	93			mg	Water	
Notes: ''Other organics'', unspecified	Output	Emission	Organics	210			mg	Air	
Notes: ''Other organics''	Output	Emission	Organics	3			mg	Water	
Notes: ''Polycyclic-HC'', <0.5 mg	Output	Emission	PAH	0.25			mg	Air	
Notes: ''Dust''	Output	Emission	Particles	2.9			g	Air	
Notes: ''Lead (Pb)'', <0.5 mg	Output	Emission	Pb	0.25			mg	Air	
Notes: ''Pb'', <0.5 mg	Output	Emission	Pb	0.25			mg	Water	
Notes: ''Phenol''	Output	Emission	Phenol	6			mg	Water	
Notes: ''Phosphate as P2O5'', 120 mg, which corresponds to 160 mg PO43- (1 g P2O5 corresponds to 1.34 g PO43-).	Output	Emission	PO43-	160			mg	Water	
Notes: ''Sulphur/sulphide'', <0.5 mg	Output	Emission	S2-	0.25			mg	Water	
Notes: ''SOx'', i.e. SO2 + SO3	Output	Emission	SO2	10			g	Air	
Notes: ''SO4--''	Output	Emission	SO42-	8.5			g	Water	
Notes: ''Suspended solids''	Output	Emission	Suspended solids	2.4			g	Water	
Notes: ''Mercaptans'', <0.5 mg	Output	Emission	Thiols	0.25			mg	Air	
Notes: ''VCM'', <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Air	
Notes: ''VCM'', <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Water	
Notes: ''Zn++'', <0.5 mg	Output	Emission	Zn	0.25			mg	Water	
Notes: ''ABS'', i.e. acrylonitrile-butadiene-styrene copolymer	Output	Product	ABS	1			kg	Technosphere	
Notes: ''Inert chemical''	Output	Residue	Inert chemical waste	3.4			g	Technosphere	
Notes: ''Mineral''	Output	Residue	Mineral waste	67			g	Technosphere	
Notes: Aggregation of different wastes: ''Mixed industrial'', 4.2 g ''Unspecified'', 6.8 g ''Construction'', 18 mg ''Metals'', 65 mg ''Paper & board'', 31 mg ''Wood waste'', 13 mg	Output	Residue	Mixed industrial waste	11.1			g	Technosphere	
Notes: ''Plastics''	Output	Residue	Plastics waste	1.8			g	Technosphere	
Notes: ''Regulated chemical''	Output	Residue	Regulated chemical waste	10			g	Technosphere	
Notes: ''Slags/ash''	Output	Residue	Slags and ash	12			g	Technosphere	
Notes: ''To incinerator''	Output	Residue	Waste to incineration	6.3			g	Technosphere	
Notes: ''To recycling''	Output	Residue	Waste to recycling	2.9			g	Technosphere	

About Inventory

Publication	''Eco-profiles of the European plastics industry'', reports for ABS (acrylonitrile-butadiene-styrene copolymer), naphtha and the other intermediates. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe) The APME project co-ordinator: Vince Matthews. The members of the original independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom. --- Editor: Data were entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 2001-06-18. Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 29 October 2001 ---
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as building blocks for use in the construction of complete life cycle analyses. 1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies. - Internal company benchmarking. - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occurred since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for ABS production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data on the ABS production processes have been supplied by 5 plants in 3 European countries. Data are probably fairly representative for production of ABS in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature.

	The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Note that emissions <0.5 mg (0.25 mg in data table) may be far below 0.5 mg in some cases. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, data for each production sequence (i.e. each plant + its specific suppliers) are calculated separately. The final result is the average of the results from the individual production sequences weighted by the output from each sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO_2 emission. CO_2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO_2 emission (kg/MJ fuel) = 3.67 x {mass fraction of carbon in fuel}/{calorific value of fuel}. The following interpretations/changes from the original report have been made by Gunnar Mattson, ABB Corporate Research: - Nuclear energy has been recalculated to natural uranium resource. - Ferromanganese, Phosphate and Rutile have been recalculated to the corresponding amounts of Mn, P and Ti resources. - The energy resources Hydrogen and Sulphur have been excluded, as these parameters do not represent true natural resources. - Emissions and resources <0.5 mg (<1 mg in the Eco-profiles result tables) are presented as 0.25 mg, i.e. 1/2 of the ''<'' value. This is in accordance with common statistical procedure.
Notes	--- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 29 October 2001 <<< Changes made by Gunnar Mattson, ABB Corporate Research: The general documentation of the data have been supplemented to improve the transparency and the consistency with other published data sets from the APME reports. The earlier published edition of the data set were named ''Production of ABS co-polymer granules'', and were documented by Sofia Medin, Electrolux Research and Innovation AB.

SPINE LCI dataset: Extraction to polycarbonate APME

Administrative	
Finished	Y
Date Completed	1997
Copyright	APME
Availability	Public

Technical System	
Name	Extraction to polycarbonate APME
Functional Unit	1 kg of polycarbonate
Functional Unit Explanation	Polycarbonate compound. Polycarbonate is a transparent, crystalline thermoplastic engineering polymer. Typical applications are: housings for domestic appliances; office equipment; electrical systems, switches and housings; compact discs and optical storage; medical devices; food containers and packaging; glazing and lightning applications; safety glasses.

Process Type	Cradle to gate
Site	European average values, Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average values, Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	Production of polycarbonate including all major operations from extraction of raw materials to polycarbonate compounding. The repeating unit in polycarbonate is -O-C6H6-C(CH3)2-C6H6-O-CO-. Polycarbonate is commonly produced by the reaction of phosgene with bisphenol A. Phosgene is produced by reacting chlorine from the electrolysis of sodium chloride with carbon monoxide produced by pyrolysis of coal, oil or gas. Usually, phosgene is manufactured on-site. Bisphenol A is produced by reacting phenol and acetone. Acetone is produced from cumene, which is produced by reacting benzene and propylene. Phenol is obtained as a co-product from acetone production from cumene, but also by oxidation of toluene. Some of the benzene and all of the toluene are produced by hydrogenating (reforming) the naphthenic compounds in naphtha. By cracking of naphtha or natural gas, propylene, hydrogen, some benzene and other by-products are produced. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha; natural gas extraction, processing and delivery; coal mining and delivery; coke production; sodium chloride extraction and purification. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i e all materials and energies have been traced back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from a number of plants in different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. Some more information about the processes are found in the ''Eco-profiles...'' report 13; for example, see process flowchart in Figure 3.

System Boundaries	
Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available.'' Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since parameters that are not monitored by the companies have been estimated. The categories used to identify the different emissions or groups of emissions are empirical. For instance, methane and aromatic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under their specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Emissions <0,5 mg are presented as <1 mg in the result tables. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	The participating companies and suppliers of major raw materials were requested to supply data for a 12 month period during 1992-94. Data for other upstream production of fuels and raw materials are probably from the same time, or somewhat older. For some of the intermediates, data published in the ''Eco-profiles...'' reports 2, 3 (1993) and 4 (1997) have been used, although additional information has been added.
Geographical Boundary	European average data. Results are based on data for polycarbonate production plants that produced 170.000 tonnes/year. Data were supplied by the 3 producers in Europe operating in Germany and the Netherlands, and are believed to be representative of the total European production of 400.000 tonnes/year.
Other Boundaries	No excluded subsystems are mentioned. No cut-off criteria for exclusion of minor inputs and outputs are stated.
Allocations	It is stated that ''those inputs and outputs, which could not be subject to stoichiometric allocation, have to be partitioned using an alternative method - usually using mass''. Stoichiometric allocation was probably applied to the electrolysis of sodium chloride. In the ''Eco-profiles...'' report 2, the following allocations were mentioned: Inputs and outputs to/from the North Sea oil rigs have been partitioned between the different products on the basis of the calorific values of the products. Inputs and outputs to/from the refineries have been partitioned across all usable or saleable refinery products on the basis of mass. This also applies to the products from the crackers.
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1992-94
Data Type	Derived, mixed
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	European average data. Results are based on data for polycarbonate production plants that produced 170.000 tonnes/year. Data were supplied by the 3 producers in Europe and are believed to be representative of the total European production of 400.000 tonnes/year. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production line (i e each polymerisation plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production lines weighted by the output from each production line (polymerisation plant). Horizontal averaging has, however, been applied for some processes over which the polycarbonate producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. Probably, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and energy, the following gross calorific values (energy content) have been used in the calculations: 45,0 MJ/kg for oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur.
Literature Reference	''Eco-profiles of the European plastics industry'' Report 13: Polycarbonate, I. Boustead, APME, 1997, data from Tables 7-13. (APME = Association of Plastics Manufacturers in Europe)
Notes	In the result tables in the ''Eco-profiles...'' report 13, not only total fuels and feedstocks, emissions to air and water, and solid waste are presented, but also the amounts caused by fuel production, fuel use, transport, feedstock (only for fuels and feedstocks) and processes. As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field, if the name has been changed significantly. The following emissions ''<1 mg'' to air have been excluded from the data set by the editor: ''N2O'', ''Cl2'', ''Pb'', ''F2'', ''Mercaptans'', H2SO4'', ''Hg''. The following emissions ''<1 mg'' to water have been excluded from the data set by the editor: ''Al3+'', ''Cu+/Cu2+'', ''Hg'', ''K+'', ''Ni2+'', ''Zn2+'', ''NO3-'', ''Dissolved Cl2'', ''Sulphur/Sulphide''. The following solid waste ''<1 mg'' has been excluded from the data set by the editor: ''To recycling''. The following raw materials <0,1 g have been excluded from the data set by the editor: ''Calcium sulphate'', ''Clay'', ''Dolomite'', ''Gravel'', ''Lead'', ''Olivine'', ''Potassium chloride'', ''Shale''. The following gross primary fuel and feedstock ''<0,01 MJ'' has been excluded from the data set by the editor: ''Wood''. 991122 SECRC/GM

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Data type: Unspecified Notes: ''Coal'', gross primary fuel and/or feedstock resource. 0,34 g ''Metallurgical coal'' is included	Input	Natural resource	*Coal (energy resource)	0.42			kg	Ground	
Data type: Unspecified Notes: ''Gas/condensate'' (natural gas), gross primary fuel and/or feedstock resource	Input	Natural resource	*Gas (energy resource)	1.4			kg	Ground	
Data type: Unspecified Notes: ''Hydro'', gross primary fuel and/or feedstock	Input	Natural resource	*Hydro power	0.39			MJ	Ground	
Data type: Unspecified Notes: ''Lignite'', gross primary fuel and/or feedstock resource	Input	Natural resource	*Lignite	0.26			kg	Ground	
Data type: Derived, mixed Literature: [1] ''Eco-profiles of the European plastics industry, Report 2: Olefin feedstock sources'', I. Boustead, APME/PWMI, 1993. [2] ''Okoinventare fur Energiesysteme'', R. Frischknecht & al, ETH, 1994. Notes: ''Nuclear'' power, 4,40 MJ, gross primary fuel and/or feedstock. If 35% efficiency [1] and 7,96 mg uranium resource/MJ electricity [2] are assumed, 4,40 MJ Nuclear power corresponds to 4,40*0,35*7,96=12,3 mg of natural uranium (*U) resource.	Input	Natural resource	*Nuclear power	4.4			MJ	Ground	
Data type: Unspecified Notes: ''Crude oil'', gross primary fuel and/or feedstock resource	Input	Natural resource	*Oil (energy resource)	0.47			kg	Ground	

Data type: Unspecified Notes: ''Air'', compressed air	Input	Natural resource	Air	810			g	Ground	
	Input	Natural resource	Bauxite	0.3			g	Ground	
	Input	Natural resource	Bentonite	1.4			g	Ground	
Data type: Unspecified Notes: ''Iron''	Input	Natural resource	Fe	0.94			g	Ground	
Data type: Unspecified Notes: ''Hydrogen'', gross primary fuel and/or feedstock	Input	Natural resource	Hydrogen	0.58			MJ	Ground	
	Input	Natural resource	Limestone	6.5			g	Ground	
	Input	Natural resource	Nitrogen	260			g	Ground	
Data type: Unspecified Notes: ''Unspecified'', gross primary fuel and/or feedstock	Input	Natural resource	Other energy	0.03			MJ	Ground	
Data type: Unspecified Notes: ''Recovered energy'', gross primary fuel and/or feedstock	Input	Natural resource	Other energy	-1.87			MJ	Ground	
	Input	Natural resource	Oxygen	26			g	Ground	
	Input	Natural resource	Sand	0.41			g	Ground	
	Input	Natural resource	Sodium chloride	790			g	Ground	
Data type: Unspecified Notes: ''Sulphur'', gross primary fuel and/or feedstock	Input	Natural resource	Sulphur	0.04			MJ	Ground	
Data type: Unspecified Notes: ''Sulphur (bonded)'': 2,3 g + ''Sulphur (elemental)'': 4,6 g Both elemental sulphur and sulphur dioxide recovered from oil refining and metallurgical processes are used for production of sulphuric acid.	Input	Natural resource	Sulphur	6.9			g	Ground	
Data type: Unspecified Notes: ''Gross water resources'', total. Aggregation of different sources: ''Public supply'': 8,3 kg, ''River/canal'': 35 kg, ''Sea'': 64 kg, ''Unspecified'': 19 kg, ''Well'': 0,45 kg. 14 kg of the water is used for processing, 110 kg for cooling.	Input	Natural resource	Water	130			kg	Ground	
Data type: Unspecified Notes: ''Acid as H+''	Output	Emission	Acidification equivalent	39			mg	Water	
Data type: Unspecified Notes: ''Aldehydes (CHO)'', unspecified	Output	Emission	Aldehydes	64			mg	Air	
Data type: Unspecified Notes: ''Aromatic-HC''s'', unspecified	Output	Emission	Aromatics	89			mg	Air	
Data type: Unspecified Notes: ''BOD'', biological oxygen demand	Output	Emission	BOD	94			mg	Water	
Data type: Unspecified Notes: ''Ca2+''	Output	Emission	Ca Calcium	0.47			g	Water	
Data type: Unspecified Notes: ''CO32-''	Output	Emission	Carbonate CO32-	26			g	Water	
Data type: Unspecified Notes: ''CFC/HCFC'', unspecified	Output	Emission	CFC average Freons	2			mg	Air	
Data type: Unspecified Notes: ''Cl-'', ''sodium and chloride ions are often discharged into salty water''	Output	Emission	Chloride Cl-	400			g	Water	
Data type: Unspecified Notes: ''CO''	Output	Emission	CO Carbon monoxide	3.6			g	Air	
Data type: Unspecified Method: CO2, unlike other emissions, is not measured but calculated from the amounts of combusted fuels. Probably, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes. Notes: ''CO2''	Output	Emission	CO2 Carbon dioxide	5			kg	Air	
Data type: Unspecified Notes: ''COD'', chemical oxygen demand	Output	Emission	COD	1			g	Water	

Data type: Unspecified Notes: ''Dissolved solids'', unspecified	Output	Emission	Dissolved solids TDS	0.2			g	Water	
Data type: Unspecified Notes: ''Dissolved organics'', unspecified	Output	Emission	DOC Dissolved organics	0.54			g	Water	
Data type: Unspecified Notes: ''Fe2+/Fe3+''	Output	Emission	Fe Iron	84			mg	Water	
Data type: Unspecified Notes: ''H2''	Output	Emission	H2 Hydrogen gas	0.24			g	Air	
Data type: Unspecified Notes: ''H2S''	Output	Emission	H2S Hydrogen sulphide	2			mg	Air	
Data type: Unspecified Notes: ''Hydrocarbons'', unspecified	Output	Emission	HC Hydrocarbons	5			g	Air	
Data type: Unspecified Notes: ''Hydrocarbons'', unspecified	Output	Emission	HC Hydrocarbons	50			mg	Water	
Data type: Unspecified Notes: ''HCl''	Output	Emission	HCl Hydrogen chloride	0.11			g	Air	
Data type: Unspecified Notes: ''HF''	Output	Emission	HF Hydrogen fluoride	4			mg	Air	
Data type: Unspecified Notes: ''Metals (unspecified)''	Output	Emission	Metal emission	0.47			g	Water	
Data type: Unspecified Notes: ''Metals'', unspecified	Output	Emission	Metal emission	3			mg	Air	
Data type: Unspecified Notes: ''CH4''	Output	Emission	Methane CH4	22			g	Air	
Data type: Unspecified Notes: ''Mg2+''	Output	Emission	Mg Magnesium	3			mg	Water	
Data type: Unspecified Notes: ''Na+'', ''sodium and chloride ions are often discharged into salty water''	Output	Emission	Na Sodium	290			g	Water	
Data type: Unspecified Notes: ''NH4+''	Output	Emission	NH4+ Ammonium	3			mg	Water	
Data type: Unspecified Notes: ''NOx''	Output	Emission	NOx	21			g	Air	
Data type: Unspecified Notes: ''Other nitrogen''	Output	Emission	N-tot Nitrogen	9			mg	Water	
Data type: Unspecified Notes: ''Detergent/oil'', unspecified	Output	Emission	Oil	50			mg	Water	
Data type: Unspecified Notes: ''Dust''	Output	Emission	Particles	7			g	Air	
Data type: Unspecified Notes: ''Phenol''	Output	Emission	Phenol C6H6O	51			mg	Water	
Data type: Unspecified Notes: ''Phosphate as P2O5'', 240 mg (corresponds to 320 mg PO43-)	Output	Emission	Phosphate PO43-	0.32			g	Water	
Data type: Unspecified Notes: ''SOx'', SO2+SO3	Output	Emission	SO2 Sulphur dioxide	13			g	Air	
Data type: Unspecified Notes: ''SO42-''	Output	Emission	Sulphate SO42-	8			g	Water	
Data type: Unspecified Notes: ''Suspended solids''	Output	Emission	Susp solids	1.2			g	Water	
Data type: Unspecified Notes: ''Other organics''	Output	Emission	TOC	36			mg	Water	
Data type: Unspecified Notes: ''Organo-Cl''	Output	Emission	TOC-chlorinated	2			mg	Water	
Data type: Unspecified Notes: ''Other organics'', unspecified	Output	Emission	VOC	0.4			g	Air	
Data type: Unspecified Notes: ''Organo-Cl'', unspecified	Output	Emission	VOC-chlorinated	0.33			g	Air	
Data type: Unspecified Notes: ''Polycarbonate''	Output	Product	Polycarbonate	1			kg	Technosphere	
Data type: Unspecified Notes: ''To incineration''	Output	Residue	Combustible waste	0.45			g	Ground	
Data type: Unspecified Notes: Aggregation of different wastes: ''Mixed industrial'': 8,6 g + ''Unspecified'': 21 mg + ''Metals'': 19 mg + ''Construction'': 11 mg	Output	Residue	Industrial waste	8.65			g	Ground	
	Output	Residue	Mineral waste	150			g	Ground	
Data type: Unspecified Notes: ''Inert chemical''	Output	Residue	Non-toxic chemicals	0.87			g	Ground	
Data type: Unspecified Notes: ''Plastics''	Output	Residue	Plastics waste	2			mg	Ground	

Data type: Unspecified Notes: ''Slags/ash''	Output	Residue	Slags and ashes	37			g	Ground	
Data type: Unspecified Notes: ''Regulated chemical''	Output	Residue	Toxic chemicals	10			g	Ground	

About Inventory	
Publication	''Eco-profiles of the European plastics industry'' Report 13: Polycarbonate, I. Boustead, APME, 1997, data from Tables 7-13. Report 2: Olefin feedstock sources, I. Boustead, APME, 1993. Report 3: Polyethylene and polypropylene, I. Boustead, APME, 1993. Report 4: Polystyrene, I. Boustead, APME, 1997 (2nd ed'n). (APME = Association of Plastics Manufacturers in Europe) The APME project co-ordinator: Vince Matthews. The members of the original independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom. -- Editor: Data entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 1999-11-22 Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Göteborg
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i e LCAs) of individual products.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The data are calculated on a cradle to gate basis, therefore, no supplier activities should be connected to, e g, nuclear power, coal and limestone.
About Data	European average data for polycarbonate production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. Data on the polycarbonate production processes have been supplied by the 3 producers in Europe and some suppliers of major raw materials. These companies were requested to supply data for a 12 month period during 1992-94. Data should be fairly representative for production of polycarbonate in Europe. However, the data quality is dependent on the quality of the records maintained by the individual companies. Site-specific data for raw materials and fuels have been used when available. Data from other manufacturers have been used in other cases. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency. No other process data have been derived from the literature. For fuels and energy, the following gross calorific values (energy content) have been used in the calculations: 45,0 MJ/kg for oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur.
Notes	

SPINE LCI dataset: Extraction to polyethylene all grades APME

Administrative	
Finished	Y

Date Completed	1993
Copyright	APME
Availability	Public

Technical System	
Name	Extraction to polyethylene all grades APME
Functional Unit	1 kg of polyethylene all grades
Functional Unit Explanation	Low density polyethylene (LDPE), high density polyethylene (HDPE) and linear low density polyethylene (LLDPE) granules. Data were obtained from a total of 36 European ethylene polymerisation plants producing 4,5E6 tonnes of polyethylene of all grades: 10 plants produced 1,3E6 tonnes of HDPE, 22 plants produced 2,8E6 tonnes of LDPE, and 4 plants produced 0,36E6 tonnes of LLDPE. Although conversion of resin to granules has been included for the granulated products, the data are based on production of all saleable products, including any sub-standard resin that is sold for other uses.
Process Type	Cradle to gate
Site	European average values, Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average values, Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	The following major processes are included: North Sea gas extraction and delivery; North Sea crude oil extraction and delivery; crude oil extraction from other sources + average tanker transport of crude oil to Europe; oil refining for naphtha; cracking of naphtha to ethene, propene etc; polymerisation of ethylene to low density polyethylene (LDPE), high density polyethylene (HDPE) or linear low density polyethylene (LLDPE); conversion of resins to granules. Also electricity production, steam production and production of other raw materials have been included on a cradle to gate basis, i e all materials and energies have been traced back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from a large number of plants in different European countries, the operating conditions differ a lot. Some general information about the chemical processes are found in the ''Eco-profiles...'' reports. The polymerisation process, for instance, are described at p 1 in Report 3. If it was not known whether a plant specifically used North Sea gas or oil, or non-North Sea oil, as the primary feedstock, it was assumed that the mix of North Sea crude oil and non-North Sea crude oil into the refineries was the same as for all EC countries (around 1990), i e 15% derived from North Sea oil and 85% from non-North Sea sources. Only data from two oil wells outside the North Sea area were available. When the ethylene sources for a polymerisation plant were known, site-specific data were used, otherwise average values. Most refineries and many polymerisation plants generate steam on-site and, in many instances, electricity is co-generated. Where plant details were not available, average values were used. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency.

System Boundaries	
Nature Boundary	As the level of detail in data supplied by the producers varied significantly from one producer to another, the level of detail in the final result is governed, to a great extent, by the returned data with the lowest level of detail. For instance, hydrocarbon emissions are presented as Hydrocarbons, although some producers provided data for individual hydrocarbons.
Time Boundary	Data were collected around 1990. The exact year is not stated. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older. For ethylene production, it is thought that the data is ''a good representation of typical averge European practice during the period 1989-90''.
Geographical Boundary	European average. No specific sites are mentioned. Data were obtained from a total of 36 European ethylene polymerisation plants producing 4,5E6 tonnes of polyethylene of all grades: 10 plants produced 1,3E6 tonnes of HDPE, 22 plants produced 2,8E6 tonnes of LDPE, and 4 plants produced 0,36E6 tonnes of LLDPE. For production of major raw materials, data were obtained from 19 crackers, 4 refineries, 3 North Sea oil rig operators, 2 non-North Sea oil wells.
Other Boundaries	Subsystems excluded: - Production of additives such as antioxidants, dyes and fillers. - Outer packaging materials for the final products. - Metallic catalysts used in polymerisation. The system boundaries for extraction of crude oil and gas, oil refining and cracking are not stated in detail, while the system boundaries for electricity production are not stated at all. Hence, it is not known what subsystems have been excluded.

	Hydrocarbon co-monomers added to the polymerisation process have all been treated as hexane. No cut-off criteria for exclusion of minor inputs and outputs are stated.
Allocations	Inputs and outputs to/from the North Sea oil rigs have been partitioned between the different products on the basis of the calorific values of the products. Inputs and outputs to/from the refineries have been partitioned across all usable or saleable refinery products on the basis of mass. This also applies to the products from the crackers.
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1990
Data Type	Derived, mixed
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	European average data. Data from 36 ethylene polymerisation plants were averaged over all plants and weighted by the production (mass) from each plant [2]. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers, otherwise horizontal averaging has been applied. In vertical averaging, each production line (i e each polymerisation plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production lines weighted by the output from each production line (polymerisation plant) [3]. For some sub-processes, plant specific data were not available, and average data for that sub-process were used instead (i e horizontal averaging). In the present data set, the proportions of oil and gas, respectively, used as fuel and feedstock, have been corrected according to instructions in ref. [3]. The reason for the correction is that a proportion of the feedstock (gas and oil) inputs to the processes invariably ends up as waste, and that these residues are generally used as fuels within the plants. As a consequence, the amount of CO2 emission to air has also been corrected, since CO2, unlike other emissions, is not measured but calculated from the amounts of combusted fuels. For fuels and energy, the following gross calorific values (energy content) have been used in the calculations: 45,0 MJ/kg for oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal. The following assumed contents of carbon in the fuels have been used in the calculations: 80% in coal, 85,71% in oil, 75,0% in gas. 1 kg carbon in a fuel gives rise to 3,67 kg of CO2.
Literature Reference	''Eco-profiles of the European plastics industry'' [1] Report 2: Olefin feedstock sources, I. Boustead, APME/PWMI, 1993. [2] Report 3: Polyethylene and polypropylene, I. Boustead, APME/PWMI, 1993, data from Tables 12-14. [3] Report 4: Polystyrene (2nd ed'n), I. Boustead, APME, 1997, p 13-14, 33. (APME = Association of Plastics Manufacturers in Europe, PWMI = European Centre for Plastics in the Environment)
Notes	As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field, if the name has been changed significantly. The following feedstock materials ''<0.01 MJ'' have been excluded from the data set by the editor: ''Coal'', ''Wood''. The following raw material ''<1 mg'' has been excluded from the data set by the editor: ''Ferromanganese''. 991122 SECRC/GM

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Data type: Unspecified Notes: ''Coal'', 2,75 MJ fuel + <0,01 MJ feedstock	Input	Natural resource	*Coal (energy resource)	2.75			MJ	Ground	
Data type: Unspecified Literature: The proportions of natural gas used as fuel and feedstock, respectively, have been corrected according to instructions in: ''Eco-profiles of the European plastics industry'' Report 4: Polystyrene (2nd ed''n) I. Boustead, APME/PWMI, 1997. Notes: ''Gas'' (natural gas), 20,96 MJ fuel + 24,16 MJ feedstock	Input	Natural resource	*Gas (energy resource)	45.12			MJ	Ground	
Data type: Unspecified Notes: ''Hydro''	Input	Natural resource	*Hydro power	0.46			MJ	Ground	
Data type: Derived, mixed Literature: [1] ''Eco-profiles of the European plastics industry, Report 2: Olefin feedstock sources'', I. Boustead, APME/PWMI, 1993. [2] ''Okoinventare fur Energiesysteme'', R. Frischknecht & al, ETH, 1994.	Input	Natural resource	*Nuclear power	1.53			MJ	Ground	

Notes: ''Nuclear'' power, 1,53 MJ. If 35% efficiency [1] and 7,96 mg uranium resource/MJ electricity [2] are assumed, 1,53 MJ Nuclear power corresponds to 1,53*0,35*7,96=4,26 mg of natural uranium (*U) resource.									
Data type: Unspecified Literature: The proportions of oil used as fuel and feedstock, respectively, have been corrected according to instructions in: ''Eco-profiles of the European plastics industry'' Report 4: Polystyrene (2nd ed''n) I. Boustead, APME/PWMI, 1997. Notes: ''Oil'' (crude oil), 12,26 MJ fuel + 23,57 MJ feedstock	Input	Natural resource	*Oil (energy resource)	35.83			MJ	Ground	
	Input	Natural resource	Bauxite	0.3			g	Ground	
	Input	Natural resource	Clay	0.02			g	Ground	
	Input	Natural resource	Iron ore	0.2			g	Ground	
	Input	Natural resource	Limestone	0.15			g	Ground	
Data type: Unspecified Notes: ''Other'' fuel, 0,14 MJ	Input	Natural resource	Other energy	0.14			MJ	Ground	
	Input	Natural resource	Sodium chloride	7			g	Ground	
	Input	Natural resource	Water	18			kg	Ground	
Data type: Unspecified Notes: ''Acid as H+''	Output	Emission	Acidification equivalent	70			mg	Water	
Data type: Unspecified Notes: ''Aldehydes'', unspecified	Output	Emission	Aldehydes	5			mg	Air	
Data type: Unspecified Notes: ''BOD'', biological oxygen demand	Output	Emission	BOD	0.15			g	Water	
Data type: Unspecified Notes: ''Chloride ions''	Output	Emission	Chloride Cl-	0.12			g	Water	
Data type: Unspecified Notes: ''Carbon monoxide''	Output	Emission	CO Carbon monoxide	0.8			g	Air	
Data type: Unspecified Method: CO2, unlike other emissions, is not measured but calculated from the amounts of combusted fuels. First, the amounts of combusted fuels were corrected by adding the feedstock (gas and oil) residues used as fuel within the processes. For fuels and energy, the following gross calorific values (energy content) have been used in the calculations: 45,0 MJ/kg for oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal. The following assumed contents of carbon in the fuels have been used in the calculations: 80% in coal, 85,71% in oil, 75,0% in gas. 1 kg carbon in a fuel gives rise to 3,67 kg of CO2. Literature: Corrected according to instructions in: ''Eco-profiles of the European plastics industry'' Report 4: Polystyrene (2nd ed''n) I. Boustead, APME/PWMI, 1997. Notes: ''Carbon dioxide''	Output	Emission	CO2 Carbon dioxide	2.22			kg	Air	
Data type: Unspecified Notes: ''COD'', chemical oxygen demand	Output	Emission	COD	1			g	Water	
Data type: Unspecified Notes: ''Dissolved solids'', unspecified	Output	Emission	Dissolved solids TDS	0.4			g	Water	
Data type: Unspecified Notes: ''Dissolved organics'', unspecified	Output	Emission	DOC Dissolved organics	20			mg	Water	
Data type: Unspecified Notes: ''Hydrogen''	Output	Emission	H2 Hydrogen gas	1			mg	Air	
Data type: Unspecified Notes: ''Hydrocarbons'', unspecified	Output	Emission	HC Hydrocarbons	0.1			g	Water	
Data type: Unspecified Notes: ''Hydrocarbons'', unspecified	Output	Emission	HC Hydrocarbons	21			g	Air	
Data type: Unspecified Notes: ''Hydrogen chloride''	Output	Emission	HCl Hydrogen chloride	60			mg	Air	

Data type: Unspecified Notes: ''Hydrogen fluoride''	Output	Emission	HF Hydrogen fluoride	1			mg	Air	
Data type: Unspecified Notes: ''Metals'', unspecified	Output	Emission	Metal emission	0.3			g	Water	
Data type: Unspecified Notes: ''Metals'', unspecified	Output	Emission	Metal emission	1			mg	Air	
Data type: Unspecified Notes: ''Ammonium ions''	Output	Emission	NH4+ Ammonium	5			mg	Water	
Data type: Unspecified Notes: ''Nitrates''	Output	Emission	Nitrate NO3-	5			mg	Water	
Data type: Unspecified Notes: ''Nitrogen oxides''	Output	Emission	NOx	11			g	Air	
Data type: Unspecified Notes: ''Other nitrogen''	Output	Emission	N-tot Nitrogen	10			mg	Water	
Data type: Unspecified Notes: ''Oil'', unspecified	Output	Emission	Oil	0.1			g	Water	
Data type: Unspecified Notes: ''Dust''	Output	Emission	Particles	2			g	Air	
Data type: Unspecified Notes: ''Phenol''	Output	Emission	Phenol C6H6O	1			mg	Water	
Data type: Unspecified Notes: ''Phosphate''	Output	Emission	Phosphate PO43-	5			mg	Water	
Data type: Unspecified Notes: ''Sulphur oxides'', SO2+SO3	Output	Emission	SO2 Sulphur dioxide	7			g	Air	
Data type: Unspecified Notes: ''Sulphate ions''	Output	Emission	Sulphate SO42-	10			mg	Water	
Data type: Unspecified Notes: ''Suspended solids''	Output	Emission	Susp solids	0.4			g	Water	
Data type: Unspecified Notes: ''Other organics'', unspecified	Output	Emission	VOC	5			mg	Air	
Data type: Unspecified Notes: ''Polyethylene (all grades)'', ''Polyethylene irrespective of grade'': LDPE, HDPE and LLDPE	Output	Product	Polyethylene all grades	1			kg	Technosphere	
	Output	Residue	Industrial waste	3.1			g	Ground	
	Output	Residue	Mineral waste	22			g	Ground	
	Output	Residue	Non-toxic chemicals	2			g	Ground	
Data type: Unspecified Notes: ''Slags & ash''	Output	Residue	Slags and ashes	7			g	Ground	
Data type: Unspecified	Output	Residue	Toxic chemicals	70			mg	Ground	

About Inventory

Publication	''Eco-profiles of the European plastics industry'' Report 2: Olefin feedstock sources Report 3: Polyethylene and polypropylene (data from Tables 12-14) I. Boustead, APME/PWMI, 1993. (APME = Association of Plastics Manufacturers in Europe, PWMI = European Centre for Plastics in the Environment) The APME project coordinator: Vince Matthews. The members of the independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom. -- Editor: Data entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 1999-11-22 Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Göteborg
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate.
Detailed Purpose	1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i e LCAs) of individual products.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .

Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The present data for polyethylene all grades could be used whenever the exact type of PE is not known. For LDPE, HDPE and LLDPE, there are specific data from APME in separate data sets. The data are calculated on a cradle to gate basis, therefore, no supplier activities should be connected to, e g, nuclear power, coal and limestone.
About Data	European average data for polyethylene production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with four independent experts on LCA (eco-balance analysis). The independent panel of experts supervised the study and developed the methodology for collecting, analysing and presenting the inventory data. The initial set of data was collected by sending out a standard questionnaire to the producers. Data on the polyethylene production processes have been supplied by the 36 producers in Europe. Data are average values weighted by the mass of polyethylene produced by each of the polymerisation plants. As a large number of producers have participated in the study, the data should be fairly representative for production of polyethylene in Europe. Site-specific data for raw materials and fuels have been used when available. Average values have been used in other cases. However, it should be borne in mind that data for some supplying processes are based on only a few plants. For instance, only data from two non-North Sea oil wells were available. The source and quality of data for public electricity production are not stated. The range of total gross energy (fuels + feedstock) consumed was 69-107 MJ/kg with a weighted average of 85,83 MJ. The range is not a statistical variation, but reflects different technologies, feedstocks, transports and operating conditions in different countries and plants. For fuels and energy, the following gross calorific values (energy content) have been used in the calculations: 45,0 MJ/kg for oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal. The accuracy of the data for air and water emissions varies for the different emissions. In general, more accurate information are available on those emissions statutorily regarded as having a more severe effect on the environment. This is because they are more closely measured in order to satisfy the local pollution regulations. Conversely, many of the non-regulated emissions are usually estimates. A large number of emissions have been aggregated into general groups, e g Metals, Hydrocarbons, Dissolved organics. The CO2 emissions to air have been calculated from the consumption of fossil fuels in the different processes. Since feedstock waste materials arising during production are used as fuels in the processes, the amounts of supplied feedstock inputs (oil and gas) should be adjusted for these residues. In the present data set, the feedstock inputs have indeed been reduced, and the fuel inputs and CO2 emissions have been increased correspondingly, in order to account for the amounts of feedstock estimated to be used as fuel.
Notes	

SPINE LCI dataset: Extraction to polyethylene HD APME

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Extraction to polyethylene HD APME
Functional Unit	1 kg of high density polyethylene (HDPE)

Functional Unit Explanation	HDPE resin, which is, for example, used in the production of HDPE food containers, automobile fuel tanks, bottles, pipes and film. It is not explained in the Eco-profiles report what is meant by ''resin'', but a fair guess is that the physical form of the polymer product is granules, as this is the most important product delivered by the polymerisation plants to their customers.
Process Type	Cradle to gate
Site	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	Production of high density polyethylene (HDPE) including all major operations from extraction of crude oil and gas to polymerisation. HDPE is produced in a low pressure process and contains fewer side branches than low density polyethylene, which accounts for a more regular structure and a higher density. Polyethylene is usually polymerised by a free radical mechanism in which an initiator opens the double bond of the ethene (CH2=CH2) molecule and attaches itself, leaving the other ''open'' bond, or radical, free to attack a further ethene molecule. The process repeats itself until all of the monomer is used up or, more commonly, the reactive end is itself terminated by specifically added reactants. Cracking of naphtha to ethene, propene etc: The output fractions from an oil refinery are complex mixtures of mostly unreactive saturated hydrocarbons. Cracking is performed to 1) reduce the variety and size of the hydrocarbons, 2) introduce unsaturation into the hydrocarbons. In addition to the mentioned processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and delivery; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been traced back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 10 plants in 7 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. Some more information about the processes are found in the ''Eco-profiles...'' reports for high density polyethylene (LDPE), ethylene and naphtha, and in the Methodology report, which are available at APME''s web site http://lca.apme.org.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available.'' Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under their specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment. Emissions <0.5 mg were presented as <1 mg in the Eco-profiles result tables. In this activity, however, they are presented as 0.25 mg (1/2 of the maximum value 0.5 mg). Note that the actual values may be far below 0.5 mg in some cases. The energy resources Hydrogen and Sulphur have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table.
Time Boundary	Data refer to the years 1992-93. Data for upstream production of crude oil, naphtha and ethylene are from 1990-96; data for production of other fuels and raw materials are probably from the same time, or somewhat older.

Geographical Boundary	European average data. Results are based on data for 10 polyethylene HD production plants that produced 1.32 million tonnes (32% of the total European production in 1997). Data were supplied by 10 plants in 7 countries: Austria, Belgium, France, Netherlands, Portugal, Sweden, UK. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates. For the intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides that plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included.) - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most other cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0.01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Methodology report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g., sulphuric acid is used as a drying agent for chlorine; therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity.
Systems Expansions	Not applied. The amount of Recovered energy is reported as a negative primary energy equivalent input.

Flow Data

General Activity QMetaData

Date Conceived	1992 to 1993
Data Type	Derived, mixed
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	European average data. Results are based on data supplied by 10 production plants in 7 countries: Austria, Belgium, France, Netherlands, Portugal, Sweden, UK. Their total production was 1.32 million tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations.

	According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. Emissions and resources <0.5 mg have been assumed by Gunnar Mattson, ABB Corporate Research (GM) to be 0.25 mg, i.e. half the ''<'' values given, which is in accordance with common statistical procedure. The energy resources Hydrogen (0.15 MJ) and Sulphur (<0.01 MJ) have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table. 2001-05-30 SECRC/GM
Literature Reference	''Eco-profiles of the European plastics industry'', reports for high density polyethylene (HDPE), ethylene and naphtha. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe)
Notes	In the result tables in the ''Eco-profiles...'' report, not only total fuels and feedstocks, emissions to air and water, and solid waste are presented, but also the amounts caused by fuel production, fuel use, transport, feedstock (only for fuels and feedstocks) and processes. As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field. Please note: Some other interpretations/changes have been made from the original report by Gunnar Mattson, ABB Corporate Research. See Method and AboutData for details.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: ''air'', compressed air	Input	Natural resource	Air	120			g	Ground	
Notes: ''barytes'', <0.5 mg	Input	Natural resource	Barytes	0.25			mg	Ground	
Notes: ''bauxite''	Input	Natural resource	Bauxite	36			g	Ground	
Notes: ''bentonite''	Input	Natural resource	Bentonite	25			mg	Ground	
Notes: ''Biomass''	Input	Natural resource	Biomass	3.4			g	Ground	
Notes: ''calcium sulphate''	Input	Natural resource	CaSO4	2			mg	Ground	
Notes: ''chalk'', <0.5 mg	Input	Natural resource	Chalk	0.25			mg	Ground	
Notes: ''chromium'', <0.5 mg	Input	Natural resource	Chromium in ore	0.25			mg	Ground	
Notes: ''clay''	Input	Natural resource	Clay	11			mg	Ground	
Notes: ''Crude oil'', gross primary fuel and/or feedstock resource, 1100 g or 49.5 MJ.	Input	Natural resource	Crude oil	1.1			kg	Ground	
Notes: ''dolomite''	Input	Natural resource	Dolomite	2			mg	Ground	
Notes: ''feldspar'', <0.5 mg	Input	Natural resource	Feldspar	0.25			mg	Ground	
Notes: ''fluorspar''	Input	Natural resource	Fluorspar	640			mg	Ground	
Notes: ''granite''	Input	Natural resource	Granite	620			mg	Ground	
Notes: ''gravel'', <0.5 mg	Input	Natural resource	Gravel	0.25			mg	Ground	
Notes: ''Coal'', gross primary fuel and/or feedstock resource, 88 g or 2.46 MJ. 52 mg ''Metallurgical coal'' is included.	Input	Natural resource	Hard coal	88			g	Ground	
Notes: ''Hydro'', gross primary energy equivalent (80% electricity production efficiency has been assumed in APME reports).	Input	Natural resource	Hydro energy	1			MJ	Ground	
Notes: ''iron''	Input	Natural resource	Iron in ore	180			mg	Ground	
Notes: ''potassium chloride''	Input	Natural resource	KCl	1			mg	Ground	
Notes: ''lead'', <0.5 mg	Input	Natural resource	Lead in ore	0.25			mg	Ground	

Notes: ''Lignite'', gross primary fuel and/or feedstock resource, 6.8 g or 0.10 MJ.	Input	Natural resource	Lignite	6.8			g	Ground	
Notes: ''limestone''	Input	Natural resource	Limestone	960			mg	Ground	
Method: ''ferromanganese'', <0.5 mg. It was assumed by SECRC/GM that the ferromanganese contained 80% Mn. Notes: ''ferromanganese''	Input	Natural resource	Manganese in ore	0.2			mg	Ground	
Notes: ''nitrogen''	Input	Natural resource	N2	65			g	Ground	
Notes: ''sodium chloride''	Input	Natural resource	NaCl	33			g	Ground	
Notes: ''Gas/condensate'' (natural gas), gross primary fuel and/or feedstock resource, 450 g or 23.9 MJ.	Input	Natural resource	Natural gas	450			g	Ground	
Notes: ''nickel'', <0.5 mg	Input	Natural resource	Nickel in ore	0.25			mg	Ground	
Notes: ''oxygen''	Input	Natural resource	O2	39			mg	Ground	
Notes: ''olivine''	Input	Natural resource	Olivine	1			mg	Ground	
Notes: ''Peat''	Input	Natural resource	Peat	270			mg	Ground	
Method: ''phosphate as P2O5'', <0.5 mg, which corresponds to <0.2 mg P (44% P in P2O5). Notes: ''phosphate as P2O5''	Input	Natural resource	Phosphorus in ore	0.1			mg	Ground	
Notes: ''sand''	Input	Natural resource	Sand	150			mg	Ground	
Notes: ''shale''	Input	Natural resource	Shale	7			mg	Ground	
Notes: ''sulphur (bonded)'', 160 mg + ''sulphur (elemental)'', 330 mg	Input	Natural resource	Sulphur in ore	490			mg	Ground	
Method: ''rutile'', <0.5 mg, which should correspond to <0.3 mg Ti, assuming that the rutile (TiO2) mineral contained 60% Ti. Notes: ''rutile''	Input	Natural resource	Titanium in ore	0.15			mg	Ground	
Notes: ''Unspecified'', gross primary fuel and/or feedstock	Input	Natural resource	Unspecified energy	0.06			MJ	Ground	
Data type: Derived, mixed Method: ''Nuclear'' energy, 3.33 MJ, gross primary energy equivalent (35% electricity production efficiency has been assumed in APME reports). 35% efficiency [1] and 7.85 mg uranium resource/MJ electricity [2] are assumed by SECRC/GM, i.e. 3.33 MJ Nuclear energy should correspond to 3.33*0.35*7.85=9.1 mg of natural uranium (U) resource. 2001-05-30 SECRC/GM Literature: [1] ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. [2] ''Oekoinventare von Energiesystemen'', R. Frischknecht & al, ETH, 1996. Notes: ''Nuclear''	Input	Natural resource	Uranium in ore	9.1			mg	Ground	
Notes: ''Gross water resources'', total. Aggregation of different sources: ''Public supply'', 2.9 kg ''River/canal'', 170 g ''Sea'', 18 kg ''Unspecified'', 35 kg ''Well'', 2.7 g 3.2 kg of the water is used for processing, 52 kg for cooling.	Input	Natural resource	Water	55			kg	Ground	
Notes: ''Wood''	Input	Natural resource	Wood	3			mg	Ground	
Notes: ''zinc'', <0.5 mg	Input	Natural resource	Zinc in ore	0.25			mg	Ground	
Notes: ''Recovered energy'', gross primary energy equivalent	Input	Refined resource	Recovered energy	-0.64			MJ	Technosphere	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Water	

Notes: "DCE", <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Air	
Notes: "Acid (H+)"	Output	Emission	Acid as H+	47			mg	Water	
Notes: "Al+++", <0.5 mg	Output	Emission	Al	0.25			mg	Water	
Notes: "Aldehydes (CHO)", unspecified, <0.5 mg	Output	Emission	Aldehydes	0.25			mg	Air	
Notes: "Aromatic-HC", unspecified	Output	Emission	Aromatics	140			mg	Air	
Notes: "Arsenic", <0.5 mg	Output	Emission	As	0.25			mg	Water	
Notes: "BOD", biochemical oxygen demand	Output	Emission	BOD	150			mg	Water	
Notes: "Ca++"	Output	Emission	Ca	21			mg	Water	
Notes: "CFC/HCFC", unspecified, <0.5 mg	Output	Emission	CFCs/HCFCs	0.25			mg	Air	
Notes: "Organo-Cl", unspecified, <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Air	
Notes: "Organo-chlorine", <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Water	
Notes: "Cl-"	Output	Emission	Cl-	340			mg	Water	
Notes: "Dissolved Cl2", <0.5 mg	Output	Emission	Cl2	0.25			mg	Water	
Notes: "Cl2", <0.5 mg	Output	Emission	Cl2	0.25			mg	Air	
Notes: "CN-", <0.5 mg	Output	Emission	CN-	0.25			mg	Water	
Notes: "CO"	Output	Emission	CO	820			mg	Air	
Method: CO2, unlike other emissions, is not measured but calculated from the amounts of combusted fuels. The amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes. CO2 emission from use of biomass has been subtracted from the total. Notes: "CO2"	Output	Emission	CO2	1.7			kg	Air	
Notes: "CO3--"	Output	Emission	CO32-	25			mg	Water	
Notes: "COD", chemical oxygen demand	Output	Emission	COD	200			mg	Water	
Notes: "CrO3", <0.5 mg, which corresponds to <0.25 mg Cr(VI), as there is 52% Cr in CrO3.	Output	Emission	Cr(VI)	0.13			mg	Water	
Notes: "CS2", <0.5 mg	Output	Emission	CS2	0.25			mg	Air	
Notes: "Cu+/Cu++", <0.5 mg	Output	Emission	Cu	0.25			mg	Water	
Notes: "Dissolved organics", unspecified	Output	Emission	Dissolved organics	27			mg	Water	
Notes: "Dissolved solids", unspecified	Output	Emission	Dissolved solids	350			mg	Water	
Notes: "F-"	Output	Emission	F-	18			mg	Water	
Notes: "F2"	Output	Emission	F2	1			mg	Air	
Notes: "Fe++/Fe+++"	Output	Emission	Fe	3			mg	Water	
Notes: "Hydrogen (H2)"	Output	Emission	H2	100			mg	Air	
Notes: "H2S"	Output	Emission	H2S	2			mg	Air	
Notes: "H2SO4", <0.5 mg	Output	Emission	H2SO4	0.25			mg	Air	
Notes: "HCl"	Output	Emission	HCl	48			mg	Air	
Notes: "HCN", <0.5 mg	Output	Emission	HCN	0.25			mg	Air	
Notes: "HF"	Output	Emission	HF	2			mg	Air	
Notes: "Mercury (Hg)", <0.5 mg	Output	Emission	Hg	0.25			mg	Air	
Notes: "Hg", <0.5 mg	Output	Emission	Hg	0.25			mg	Water	
Notes: "Hydrocarbons", unspecified	Output	Emission	Hydrocarbons	5.9			g	Air	
Notes: "Hydrocarbons", unspecified	Output	Emission	Hydrocarbons	51			mg	Water	
Notes: "K+", <0.5 mg	Output	Emission	K	0.25			mg	Water	
Notes: "Metals - unspecified"	Output	Emission	Metals	48			mg	Water	
Notes: "Metals", unspecified	Output	Emission	Metals	8			mg	Air	
Notes: "Methane"	Output	Emission	Methane	5.7			g	Air	
Notes: "Mg++"	Output	Emission	Mg	3			mg	Water	
Notes: "Other nitrogen"	Output	Emission	N total	8			mg	Water	
Notes: "N2O", <0.5 mg	Output	Emission	N2O	0.25			mg	Air	
Notes: "Na+"	Output	Emission	Na	370			mg	Water	
Notes: "Ammonia (NH3)", <0.5 mg	Output	Emission	NH3	0.25			mg	Air	
Notes: "NH4"	Output	Emission	NH4+	11			mg	Water	
Notes: "Ni++", <0.5 mg	Output	Emission	Ni	0.25			mg	Water	
Notes: "NO3-"	Output	Emission	NO3-	6			mg	Water	
Notes: "NOx"	Output	Emission	NOx	9.9			g	Air	

Notes: ''Detergent/oil'', unspecified	Output	Emission	Oil	68			mg	Water	
Notes: ''Other organics''	Output	Emission	Organics	2			mg	Water	
Notes: ''Other organics'', unspecified	Output	Emission	Organics	5			mg	Air	
Notes: ''Polycyclic-HC'', <0.5 mg	Output	Emission	PAH	0.25			mg	Air	
Notes: ''Dust''	Output	Emission	Particles	2.9			g	Air	
Notes: ''Pb'', <0.5 mg	Output	Emission	Pb	0.25			mg	Water	
Notes: ''Lead (Pb)'', <0.5 mg	Output	Emission	Pb	0.25			mg	Air	
Notes: ''Phenol''	Output	Emission	Phenol	4			mg	Water	
Notes: ''Phosphate as P2O5'', 1 mg, which corresponds to 1.3 mg PO43- (1 g P2O5 corresponds to 1.34 g PO43-).	Output	Emission	PO43-	1.3			mg	Water	
Notes: ''Sulphur/sulphide''	Output	Emission	S2-	5			mg	Water	
Notes: ''SOx'', i.e. SO2 + SO3	Output	Emission	SO2	14			g	Air	
Notes: ''SO4--''	Output	Emission	SO42-	49			mg	Water	
Notes: ''Suspended solids''	Output	Emission	Suspended solids	2.1			g	Water	
Notes: ''Mercaptans'', <0.5 mg	Output	Emission	Thiols	0.25			mg	Air	
Notes: ''VCM'', <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Water	
Notes: ''VCM'', <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Air	
Notes: ''Zn++'', <0.5 mg	Output	Emission	Zn	0.25			mg	Water	
Notes: ''Polyethylene resin (high density)'', high density polyethylene (HDPE)	Output	Product	Polyethylene HD	1			kg	Technosphere	
Notes: ''Inert chemical''	Output	Residue	Inert chemical waste	540			mg	Technosphere	
Notes: ''Mineral''	Output	Residue	Mineral waste	74			g	Technosphere	
Notes: Aggregation of different wastes: ''Mixed industrial'', 2.9 g ''Unspecified'', 1.2 g ''Construction'', 280 mg ''Metals'', 12 mg ''Paper & board'', <1 mg ''Wood waste'', <1 mg	Output	Residue	Mixed industrial waste	4.4			g	Technosphere	
Notes: ''Plastics''	Output	Residue	Plastics waste	11			mg	Technosphere	
Notes: ''Regulated chemical''	Output	Residue	Regulated chemical waste	7.8			g	Technosphere	
Notes: ''Slags/ash''	Output	Residue	Slags and ash	5.8			g	Technosphere	
Notes: ''To incinerator''	Output	Residue	Waste to incineration	29			mg	Technosphere	
Notes: ''To recycling''	Output	Residue	Waste to recycling	11			mg	Technosphere	

About Inventory

Publication	''Eco-profiles of the European plastics industry'', reports for high density polyethylene (HDPE), ethylene and naphtha. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe) The APME project co-ordinator: Vince Matthews. The members of the original independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom. -- Editor: Data were entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 2001-05-30. Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 29 October 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as building blocks for use in the construction of complete life cycle analyses. 1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of

	individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies. - Internal company benchmarking. - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occurred since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for high density polyethylene production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data on the HDPE production processes have been supplied by 10 plants in 7 European countries. Data are probably fairly representative for production of HDPE in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Note that emissions <0.5 mg (0.25 mg in data table) may be far below 0.5 mg in some cases. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, data for each production sequence (i.e. each plant + its specific suppliers) are calculated separately. The final result is the average of the results from the individual production sequences weighted by the output from each sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission (kg/MJ fuel) = 3.67 x {mass fraction of carbon in fuel}/{calorific value of fuel}. The following interpretations/changes have been made by Gunnar Mattson, ABB Corporate Research: - Nuclear energy has been recalculated to natural uranium resource. - Ferromanganese, Phosphate and Rutile have been recalculated to the corresponding amounts of Mn, P and Ti resources.

	- The energy resources Hydrogen and Sulphur have been excluded, as these parameters do not represent true natural resources. - Emissions and resources <0.5 mg (<1 mg in the Eco-profiles result tables) are presented as 0.25 mg, i.e. 1/2 of the ''<'' value. This is in accordance with common statistical procedure.
Notes	

SPINE LCI dataset: Extraction to polyethylene LD APME

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Extraction to polyethylene LD APME
Functional Unit	1 kg of low density polyethylene (LDPE)
Functional Unit Explanation	LDPE resin, which is typically used in the production of LDPE film and containers. It is not explained in the Eco-profiles report what is meant by ''resin'', but a fair guess is that the physical form of the polymer product is granules, as this is the most important product delivered by the polymerisation plants to their customers.
Process Type	Cradle to gate
Site	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	Production of low density polyethylene (LDPE) including all major operations from extraction of crude oil and gas to polymerisation. LDPE is produced in a high pressure process and contains a high level of side branching with relatively long side chains, which accounts for LDPE''s relatively low density. Polyethylene is usually polymerised by a free radical mechanism in which an initiator opens the double bond of the ethene (CH2=CH2) molecule and attaches itself, leaving the other ''open'' bond, or radical, free to attack a further ethene molecule. The process repeats itself until all of the monomer is used up or, more commonly, the reactive end is itself terminated by specifically added reactants. Cracking of naphtha to ethene, propene etc: The output fractions from an oil refinery are complex mixtures of mostly unreactive saturated hydrocarbons. Cracking is performed to 1) reduce the variety and size of the hydrocarbons, 2) introduce unsaturation into the hydrocarbons. In addition to the mentioned processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and delivery; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been traced back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 15 plants in 7 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. Some more information about the processes are found in the ''Eco-profiles...'' reports for low density polyethylene (LDPE), ethylene and naphtha, and in the Methodology report, which are available at APME''s web site http://lca.apme.org.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available.'' Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under their specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment. Emissions <0.5 mg were presented as <1 mg in the Eco-profiles result tables. In this activity, however, they are presented as 0.25 mg (1/2 of the maximum value 0.5 mg). Note that the actual values may be far below 0.5 mg in some cases. The energy resources Hydrogen and Sulphur have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table.
Time Boundary	Data refer to the years 1989-92. Data for upstream production of crude oil, naphtha and ethylene are from 1990-96; data for production of other fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data for 15 polyethylene LD production plants that produced 2.3 million tonnes (47% of the total European production in 1997). Data were supplied by 15 plants in 7 countries: Austria, Belgium, Finland, Netherlands, Portugal, Sweden, UK. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates. For the intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides that plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included.) - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most other cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0.01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Methodology report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g., sulphuric acid is used as a drying agent for chlorine; therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or

	chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity.
Systems Expansions	Not applied. The amount of Recovered energy is reported as a negative primary energy equivalent input.

Flow Data

General Activity QMetaData

Date Conceived	1989 to 1992
Data Type	Derived, mixed
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	European average data. Results are based on data supplied by 15 production plants in 7 countries: Austria, Belgium, Finland, Netherlands, Portugal, Sweden, UK. Their total production was 2.3 million tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. Emissions and resources <0.5 mg have been assumed by Gunnar Mattson, ABB Corporate Research (GM) to be 0.25 mg, i.e. half the ''<'' values given, which is in accordance with common statistical procedure. The energy resources Hydrogen (0.11 MJ) and Sulphur (<0.01 MJ) have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table. 2001-05-29 SECRC/GM
Literature Reference	''Eco-profiles of the European plastics industry'', reports for low density polyethylene (LDPE), ethylene and naphtha. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe)
Notes	In the result tables in the ''Eco-profiles...'' report, not only total fuels and feedstocks, emissions to air and water, and solid waste are presented, but also the amounts caused by fuel production, fuel use, transport, feedstock (only for fuels and feedstocks) and processes. As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field. Please note: Some other interpretations/changes have been made from the original report by Gunnar Mattson, ABB Corporate Research. See Method and AboutData for details.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: ''air'', compressed air	Input	Natural resource	Air	100			g	Ground	
Notes: ''barytes'', <0.5 mg	Input	Natural resource	Barytes	0.25			mg	Ground	
Notes: ''bauxite''	Input	Natural resource	Bauxite	890			mg	Ground	
Notes: ''bentonite''	Input	Natural resource	Bentonite	45			mg	Ground	
Notes: ''Biomass''	Input	Natural resource	Biomass	9.1			g	Ground	
Notes: ''calcium sulphate''	Input	Natural resource	CaSO4	4			mg	Ground	
Notes: ''chalk'', <0.5 mg	Input	Natural resource	Chalk	0.25			mg	Ground	
Notes: ''chromium'', <0.5 mg	Input	Natural resource	Chromium in ore	0.25			mg	Ground	

Notes: ''clay''	Input	Natural resource	Clay	15			mg	Ground	
Notes: ''Crude oil'', gross primary fuel and/or feedstock resource, 700 g or 31.4 MJ.	Input	Natural resource	Crude oil	700			g	Ground	
Notes: ''dolomite''	Input	Natural resource	Dolomite	2			mg	Ground	
Notes: ''feldspar'', <0.5 mg	Input	Natural resource	Feldspar	0.25			mg	Ground	
Notes: ''fluorspar''	Input	Natural resource	Fluorspar	5			mg	Ground	
Notes: ''granite'', <0.5 mg	Input	Natural resource	Granite	0.25			mg	Ground	
Notes: ''gravel''	Input	Natural resource	Gravel	1			mg	Ground	
Notes: ''Coal'', gross primary fuel and/or feedstock resource, 100 g or 2.81 MJ. 73 mg ''Metallurgical coal'' is included.	Input	Natural resource	Hard coal	100			g	Ground	
Notes: ''Hydro'', gross primary energy equivalent (80% electricity production efficiency has been assumed in APME reports).	Input	Natural resource	Hydro energy	1.31			MJ	Ground	
Notes: ''iron''	Input	Natural resource	Iron in ore	260			mg	Ground	
Notes: ''potassium chloride''	Input	Natural resource	KCl	1			mg	Ground	
Notes: ''lead'', <0.5 mg	Input	Natural resource	Lead in ore	0.25			mg	Ground	
Notes: ''Lignite'', gross primary fuel and/or feedstock resource, 7.7 g or 0.12 MJ.	Input	Natural resource	Lignite	7.7			g	Ground	
Notes: ''limestone''	Input	Natural resource	Limestone	1.4			g	Ground	
Method: ''ferromanganese'', <0.5 mg. It was assumed by SECRC/GM that the ferromanganese contained 80% Mn. Notes: ''ferromanganese''	Input	Natural resource	Manganese in ore	0.2			mg	Ground	
Notes: ''nitrogen''	Input	Natural resource	N2	16			g	Ground	
Notes: ''sodium chloride''	Input	Natural resource	NaCl	1.3			g	Ground	
Notes: ''Gas/condensate'' (natural gas), gross primary fuel and/or feedstock resource, 800 g or 42.4 MJ.	Input	Natural resource	Natural gas	800			g	Ground	
Notes: ''nickel'', <0.5 mg	Input	Natural resource	Nickel in ore	0.25			mg	Ground	
Notes: ''oxygen''	Input	Natural resource	O2	31			mg	Ground	
Notes: ''olivine''	Input	Natural resource	Olivine	2			mg	Ground	
Notes: ''Peat''	Input	Natural resource	Peat	7.2			g	Ground	
Method: ''phosphate as P2O5'', <0.5 mg, which corresponds to <0.2 mg P (44% P in P2O5). Notes: ''phosphate as P2O5''	Input	Natural resource	Phosphorus in ore	0.1			mg	Ground	
Notes: ''sand''	Input	Natural resource	Sand	220			mg	Ground	
Notes: ''shale''	Input	Natural resource	Shale	13			mg	Ground	
Notes: ''sulphur (bonded)'', 20 mg + ''sulphur (elemental)'', 45 mg	Input	Natural resource	Sulphur in ore	65			mg	Ground	
Method: ''rutile'', <0.5 mg, which should correspond to <0.3 mg Ti, assuming that the rutile (TiO2) mineral contained 60% Ti. Notes: ''rutile''	Input	Natural resource	Titanium in ore	0.15			mg	Ground	
Notes: ''Unspecified'', gross primary fuel and/or feedstock	Input	Natural resource	Unspecified energy	0.06			MJ	Ground	
Data type: Derived, mixed Method: ''Nuclear'' energy, 3.70 MJ, gross primary energy equivalent (35% electricity production efficiency has been assumed in APME reports). 35% efficiency [1] and 7.85 mg uranium	Input	Natural resource	Uranium in ore	10.2			mg	Ground	

resource/MJ electricity [2] are assumed by SECRC/GM, i.e. 3.70 MJ Nuclear energy should correspond to 3.70*0.35*7.85=10.2 mg of natural uranium (U) resource. 2001-05-29 SECRC/GM Literature: [1] ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. [2] ''Oekoinventare von Energiesystemen'', R. Frischknecht & al, ETH, 1996. Notes: ''Nuclear''									
Notes: ''Gross water resources'', total. Aggregation of different sources: ''Public supply'', 3.1 kg ''River/canal'', 130 g ''Sea'', 25 kg ''Unspecified'', 33 kg ''Well'', 2 g 3.4 kg of the water is used for processing, 57 kg for cooling.	Input	Natural resource	Water	60			kg	Ground	
Notes: ''Wood''	Input	Natural resource	Wood	2			mg	Ground	
Notes: ''zinc'', <0.5 mg	Input	Natural resource	Zinc in ore	0.25			mg	Ground	
Notes: ''Recovered energy'', gross primary energy equivalent	Input	Refined resource	Recovered energy	-1.5			MJ	Technosphere	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Water	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Air	
Notes: ''Acid (H+)''	Output	Emission	Acid as H+	63			mg	Water	
Notes: ''Al+++'', <0.5 mg	Output	Emission	Al	0.25			mg	Water	
Notes: ''Aldehydes (CHO)'', unspecified	Output	Emission	Aldehydes	8			mg	Air	
Notes: ''Aromatic-HC'', unspecified	Output	Emission	Aromatics	29			mg	Air	
Notes: ''Arsenic'', <0.5 mg	Output	Emission	As	0.25			mg	Water	
Notes: ''BOD'', biochemical oxygen demand	Output	Emission	BOD	130			mg	Water	
Notes: ''Ca++''	Output	Emission	Ca	1			mg	Water	
Notes: ''CFC/HCFC'', unspecified	Output	Emission	CFCs/HCFCs	7			mg	Air	
Notes: ''Organo-Cl'', unspecified, <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Air	
Notes: ''Organo-chlorine'', <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Water	
Notes: ''Cl-''	Output	Emission	Cl-	280			mg	Water	
Notes: ''Dissolved Cl2'', <0.5 mg	Output	Emission	Cl2	0.25			mg	Water	
Notes: ''Cl2'', <0.5 mg	Output	Emission	Cl2	0.25			mg	Air	
Notes: ''CN-'', <0.5 mg	Output	Emission	CN-	0.25			mg	Water	
Notes: ''CO''	Output	Emission	CO	1.1			g	Air	
Method: CO2, unlike other emissions, is not measured but calculated from the amounts of combusted fuels. The amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes. CO2 emission from use of biomass has been subtracted from the total. Notes: ''CO2''	Output	Emission	CO2	1.9			kg	Air	
Notes: ''CO3--''	Output	Emission	CO32-	42			mg	Water	
Notes: ''COD'', chemical oxygen demand	Output	Emission	COD	470			mg	Water	
Notes: ''CrO3'', <0.5 mg, which corresponds to <0.25 mg Cr(VI), as there is 52% Cr in CrO3.	Output	Emission	Cr(VI)	0.13			mg	Water	
Notes: ''CS2'', <0.5 mg	Output	Emission	CS2	0.25			mg	Air	
Notes: ''Cu+/Cu++'', <0.5 mg	Output	Emission	Cu	0.25			mg	Water	
Notes: ''Dissolved organics'', unspecified	Output	Emission	Dissolved organics	37			mg	Water	
Notes: ''Dissolved solids'', unspecified	Output	Emission	Dissolved solids	160			mg	Water	
Notes: ''F-'', <0.5 mg	Output	Emission	F-	0.25			mg	Water	
Notes: ''F2'', <0.5 mg	Output	Emission	F2	0.25			mg	Air	
Notes: ''Fe++/Fe+++'', <0.5 mg	Output	Emission	Fe	0.25			mg	Water	
Notes: ''Hydrogen (H2)''	Output	Emission	H2	72			mg	Air	

Notes: ''H2S''	Output	Emission	H2S	1			mg	Air	
Notes: ''H2SO4'', <0.5 mg	Output	Emission	H2SO4	0.25			mg	Air	
Notes: ''HCl''	Output	Emission	HCl	56			mg	Air	
Notes: ''HCN'', <0.5 mg	Output	Emission	HCN	0.25			mg	Air	
Notes: ''HF''	Output	Emission	HF	3			mg	Air	
Notes: ''Mercury (Hg)'', <0.5 mg	Output	Emission	Hg	0.25			mg	Air	
Notes: ''Hg'', <0.5 mg	Output	Emission	Hg	0.25			mg	Water	
Notes: ''Hydrocarbons'', unspecified	Output	Emission	Hydrocarbons	45			mg	Water	
Notes: ''Hydrocarbons'', unspecified	Output	Emission	Hydrocarbons	6.8			g	Air	
Notes: ''K+'', <0.5 mg	Output	Emission	K	0.25			mg	Water	
Notes: ''Metals - unspecified''	Output	Emission	Metals	120			mg	Water	
Notes: ''Metals'', unspecified	Output	Emission	Metals	3			mg	Air	
Notes: ''Methane''	Output	Emission	Methane	5.8			g	Air	
Notes: ''Mg++'', <0.5 mg	Output	Emission	Mg	0.25			mg	Water	
Notes: ''Other nitrogen''	Output	Emission	N total	2			mg	Water	
Notes: ''N2O'', <0.5 mg	Output	Emission	N2O	0.25			mg	Air	
Notes: ''Na+''	Output	Emission	Na	190			mg	Water	
Notes: ''Ammonia (NH3)'', <0.5 mg	Output	Emission	NH3	0.25			mg	Air	
Notes: ''NH4''	Output	Emission	NH4+	8			mg	Water	
Notes: ''Ni++'', <0.5 mg	Output	Emission	Ni	0.25			mg	Water	
Notes: ''NO3-''	Output	Emission	NO3-	5			mg	Water	
Notes: ''NOx''	Output	Emission	NOx	9.6			g	Air	
Notes: ''Detergent/oil'', unspecified	Output	Emission	Oil	180			mg	Water	
Notes: ''Other organics'', unspecified	Output	Emission	Organics	18			mg	Air	
Notes: ''Other organics''	Output	Emission	Organics	7			mg	Water	
Notes: ''Polycyclic-HC'', <0.5 mg	Output	Emission	PAH	0.25			mg	Air	
Notes: ''Dust''	Output	Emission	Particles	2			g	Air	
Notes: ''Pb'', <0.5 mg	Output	Emission	Pb	0.25			mg	Water	
Notes: ''Lead (Pb)'', <0.5 mg	Output	Emission	Pb	0.25			mg	Air	
Notes: ''Phenol''	Output	Emission	Phenol	3			mg	Water	
Notes: ''Phosphate as P2O5'', 4 mg, which corresponds to 5.4 mg PO43- (1 g P2O5 corresponds to 1.34 g PO43-).	Output	Emission	PO43-	5.4			mg	Water	
Notes: ''Sulphur/sulphide''	Output	Emission	S2-	10			mg	Water	
Notes: ''SOx'', i.e. SO2 + SO3	Output	Emission	SO2	8.3			g	Air	
Notes: ''SO4--''	Output	Emission	SO42-	87			mg	Water	
Notes: ''Suspended solids''	Output	Emission	Suspended solids	220			mg	Water	
Notes: ''Mercaptans'', <0.5 mg	Output	Emission	Thiols	0.25			mg	Air	
Notes: ''VCM'', <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Water	
Notes: ''VCM'', <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Air	
Notes: ''Zn++'', <0.5 mg	Output	Emission	Zn	0.25			mg	Water	
Notes: ''Polyethylene resin (low density)'', low density polyethylene (LDPE)	Output	Product	Polyethylene LD	1			kg	Technosphere	
Notes: ''Inert chemical''	Output	Residue	Inert chemical waste	490			mg	Technosphere	
Notes: ''Mineral''	Output	Residue	Mineral waste	22			g	Technosphere	
Notes: Aggregation of different wastes: ''Mixed industrial'', 1.9 g ''Unspecified'', 350 mg ''Construction'', 8 mg ''Metals'', 9 mg ''Paper & board'', <1 mg ''Wood waste'', <1 mg	Output	Residue	Mixed industrial waste	2.3			g	Technosphere	
Notes: ''Plastics''	Output	Residue	Plastics waste	71			mg	Technosphere	
Notes: ''Regulated chemical''	Output	Residue	Regulated chemical waste	1.5			g	Technosphere	
Notes: ''Slags/ash''	Output	Residue	Slags and ash	7			g	Technosphere	
Notes: ''To incinerator''	Output	Residue	Waste to incineration	120			mg	Technosphere	
Notes: ''To recycling''	Output	Residue	Waste to recycling	6			mg	Technosphere	

About Inventory

Publication	''Eco-profiles of the European plastics industry'', reports for low density polyethylene (LDPE), ethylene and naphtha. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org.

	(APME = Association of Plastics Manufacturers in Europe) The APME project co-ordinator: Vince Matthews. The members of the original independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom. -- Editor: Data were entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 2001-05-29. Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 29 October 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as building blocks for use in the construction of complete life cycle analyses. 1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies. - Internal company benchmarking. - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occurred since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for low density polyethylene production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data on the LDPE production processes have been supplied by 15 plants in 7 European countries. Data are probably fairly representative for production of LDPE in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Note that emissions <0.5 mg (0.25 mg in data table) may be far below 0.5 mg in some cases.

	Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, data for each production sequence (i.e. each plant + its specific suppliers) are calculated separately. The final result is the average of the results from the individual production sequences weighted by the output from each sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission (kg/MJ fuel) = 3.67 x {mass fraction of carbon in fuel}/{calorific value of fuel}. The following interpretations/changes from the original report have been made by Gunnar Mattson, ABB Corporate Research: - Nuclear energy has been recalculated to natural uranium resource. - Ferromanganese, Phosphate and Rutile have been recalculated to the corresponding amounts of Mn, P and Ti resources. - The energy resources Hydrogen and Sulphur have been excluded, as these parameters do not represent true natural resources. - Emissions and resources <0.5 mg (<1 mg in the Eco-profiles result tables) are presented as 0.25 mg, i.e. 1/2 of the ''<'' value. This is in accordance with common statistical procedure.
Notes	

SPINE LCI dataset: Extraction to polyethylene linear LD APME

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Extraction to polyethylene linear LD APME
Functional Unit	1 kg of linear low density polyethylene (LLDPE)
Functional Unit Explanation	LLDPE resin. It is not explained in the Eco-profiles report what is meant by ''resin'', but a fair guess is that the physical form of the polymer product is granules, as this is the most important product delivered by the polymerisation plants to their customers.
Process Type	Cradle to gate
Site	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	Production of linear low density polyethylene (LLDPE) including all major operations from extraction of crude oil and gas to polymerisation. LLDPE contains a large number of side branches but they are very short so that the polymer is able to pack well in the solid state. Polyethylene is usually polymerised by a free radical mechanism in which an initiator opens the double bond of the ethene (CH2=CH2) molecule and attaches itself, leaving the other ''open'' bond, or radical, free to attack a further ethene molecule. The process repeats itself until all of the monomer is used up or, more commonly,

	the reactive end is itself terminated by specifically added reactants. Cracking of naphtha to ethene, propene etc: The output fractions from an oil refinery are complex mixtures of mostly unreactive saturated hydrocarbons. Cracking is performed to 1) reduce the variety and size of the hydrocarbons, 2) introduce unsaturation into the hydrocarbons. In addition to the mentioned processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and delivery; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been traced back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 3 plants in 2 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. Some more information about the processes are found in the ''Eco-profiles...'' reports for linear low density polyethylene (LLDPE), ethylene and naphtha, and in the Methodology report, which are available at APME''s web site http://lca.apme.org.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available.'' Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under their specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment. Emissions <0.5 mg were presented as <1 mg in the Eco-profiles result tables. In this activity, however, they are presented as 0.25 mg (1/2 of the maximum value 0.5 mg). Note that the actual values may be far below 0.5 mg in some cases. The energy resources Hydrogen and Sulphur have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table.
Time Boundary	Data refer to the years 1990-92. Data for upstream production of crude oil, naphtha and ethylene are from 1990-96; data for production of other fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data for 3 polyethylene linear LD production plants that produced 341000 tonnes (21% of the total European production in 1997). Data were supplied by 3 plants in 2 countries: France, Netherlands. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates. For the intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides that plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included.) - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most other cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0.01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Methodology report, a general recommendation is given that it is important to demonstrate

	that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g., sulphuric acid is used as a drying agent for chlorine; therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity.
Systems Expansions	Not applied. The amount of Recovered energy is reported as a negative primary energy equivalent input.

Flow Data

General Activity QMetaData

Date Conceived	1990 to 1992
Data Type	Derived, mixed
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	European average data. Results are based on data supplied by 3 production plants in 2 countries: France, Netherlands. Their total production was 341000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. Emissions and resources <0.5 mg have been assumed by GM to be 0.25 mg, i.e. half the ''<'' values given, which is in accordance with common statistical procedure. The energy resources Hydrogen (0.02 MJ) and Sulphur (<0.01 MJ) have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table. 2001-05-30 SECRC/GM
Literature Reference	''Eco-profiles of the European plastics industry'', reports for linear low density polyethylene (LLDPE), ethylene and naphtha. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe)
Notes	In the result tables in the ''Eco-profiles...'' report, not only total fuels and feedstocks, emissions to air and water, and solid waste are presented, but also the amounts caused by fuel production, fuel use, transport, feedstock (only for fuels and feedstocks) and processes. As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field. Please note: Some other interpretations/changes have been made from the original report by Gunnar Mattson, ABB Corporate Research. See Method and AboutData for details.

Flow Table and Specific Meta Data									
QMetaData	**Direction**	**FlowType**	**Substance**	**Quantity**	**Min**	**Max**	**Unit**	**Environment**	**Geography**
Notes: ''air'', compressed air	Input	Natural resource	Air	54			g	Ground	
Notes: ''barytes'', <0.5 mg	Input	Natural resource	Barytes	0.25			mg	Ground	
Notes: ''bauxite''	Input	Natural resource	Bauxite	430			mg	Ground	
Notes: ''bentonite''	Input	Natural resource	Bentonite	230			mg	Ground	
Notes: ''Biomass''	Input	Natural resource	Biomass	2.1			g	Ground	
Notes: ''calcium sulphate''	Input	Natural resource	CaSO4	23			mg	Ground	
Notes: ''chalk'', <0.5 mg	Input	Natural resource	Chalk	0.25			mg	Ground	
Notes: ''chromium'', <0.5 mg	Input	Natural resource	Chromium in ore	0.25			mg	Ground	
Notes: ''clay''	Input	Natural resource	Clay	11			mg	Ground	
Notes: ''Crude oil'', gross primary fuel and/or feedstock resource, 440 g or 20.0 MJ.	Input	Natural resource	Crude oil	440			g	Ground	
Notes: ''dolomite''	Input	Natural resource	Dolomite	9			mg	Ground	
Notes: ''feldspar'', <0.5 mg	Input	Natural resource	Feldspar	0.25			mg	Ground	
Notes: ''fluorspar'', <0.5 mg	Input	Natural resource	Fluorspar	0.25			mg	Ground	
Notes: ''granite'', <0.5 mg	Input	Natural resource	Granite	0.25			mg	Ground	
Notes: ''gravel''	Input	Natural resource	Gravel	3			mg	Ground	
Notes: ''Coal'', gross primary fuel and/or feedstock resource, 21 g or 0.60 MJ. 310 mg ''Metallurgical coal'' is included.	Input	Natural resource	Hard coal	21			g	Ground	
Notes: ''Hydro'', gross primary energy equivalent (80% electricity production efficiency has been assumed in APME reports).	Input	Natural resource	Hydro energy	0.17			MJ	Ground	
Notes: ''iron''	Input	Natural resource	Iron in ore	820			mg	Ground	
Notes: ''potassium chloride''	Input	Natural resource	KCl	1			mg	Ground	
Notes: ''lead'', <0.5 mg	Input	Natural resource	Lead in ore	0.25			mg	Ground	
Notes: ''Lignite'', gross primary fuel and/or feedstock resource, 1.4 g or 0.02 MJ.	Input	Natural resource	Lignite	1.4			g	Ground	
Notes: ''limestone''	Input	Natural resource	Limestone	1.2			g	Ground	
Method: ''ferromanganese'', 1 mg. It was assumed by SECRC/GM that the ferromanganese contained 80% Mn. Notes: ''ferromanganese''	Input	Natural resource	Manganese in ore	0.8			mg	Ground	
Notes: ''nitrogen''	Input	Natural resource	N2	97			g	Ground	
Notes: ''sodium chloride''	Input	Natural resource	NaCl	1.1			g	Ground	
Notes: ''Gas/condensate'' (natural gas), gross primary fuel and/or feedstock resource, 1000 g or 52.9 MJ.	Input	Natural resource	Natural gas	1			kg	Ground	
Notes: ''nickel'', <0.5 mg	Input	Natural resource	Nickel in ore	0.25			mg	Ground	
Notes: ''oxygen''	Input	Natural resource	O2	17			mg	Ground	
Notes: ''olivine''	Input	Natural resource	Olivine	7			mg	Ground	
Notes: ''Peat''	Input	Natural resource	Peat	8			mg	Ground	

Method: ''phosphate as P2O5'', <0.5 mg, which corresponds to <0.2 mg P (44% P in P2O5). Notes: ''phosphate as P2O5''	Input	Natural resource	Phosphorus in ore	0.1			mg	Ground	
Notes: ''sand''	Input	Natural resource	Sand	200			mg	Ground	
Notes: ''shale''	Input	Natural resource	Shale	66			mg	Ground	
Notes: ''sulphur (bonded)'', 6 mg + ''sulphur (elemental)'', 18 mg	Input	Natural resource	Sulphur in ore	24			mg	Ground	
Method: ''rutile'', <0.5 mg, which should correspond to <0.3 mg Ti, assuming that the rutile (TiO2) mineral contained 60% Ti. Notes: ''rutile''	Input	Natural resource	Titanium in ore	0.15			mg	Ground	
Notes: ''Unspecified'', gross primary fuel and/or feedstock	Input	Natural resource	Unspecified energy	0.01			MJ	Ground	
Data type: Derived, mixed Method: ''Nuclear'' energy, 1.74 MJ, gross primary energy equivalent (35% electricity production efficiency has been assumed in APME reports). 35% efficiency [1] and 7.85 mg uranium resource/MJ electricity [2] are assumed by SECRC/GM, i.e. 1.74 MJ Nuclear energy should correspond to 1.74*0.35*7.85=4.8 mg of natural uranium (U) resource. 2001-05-30 SECRC/GM Literature: [1] ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. [2] ''Oekoinventare von Energiesystemen'', R. Frischknecht & al, ETH, 1996. Notes: ''Nuclear''	Input	Natural resource	Uranium in ore	4.8			mg	Ground	
Notes: ''Gross water resources'', total. Aggregation of different sources: ''Public supply'', 2.5 kg ''River/canal'', 22 g ''Sea'', 116 kg ''Unspecified'', 5.4 kg ''Well'', 340 g 2.6 kg of the water is used for processing, 121 kg for cooling.	Input	Natural resource	Water	124			kg	Ground	
Notes: ''Wood'', <0.5 mg	Input	Natural resource	Wood	0.25			mg	Ground	
Notes: ''zinc''	Input	Natural resource	Zinc in ore	110			mg	Ground	
Notes: ''Recovered energy'', gross primary energy equivalent	Input	Refined resource	Recovered energy	-3.12			MJ	Technosphere	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Water	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Air	
Notes: ''Acid (H+)''	Output	Emission	Acid as H+	40			mg	Water	
Notes: ''Al+++'', <0.5 mg	Output	Emission	Al	0.25			mg	Water	
Notes: ''Aldehydes (CHO)'', unspecified, <0.5 mg	Output	Emission	Aldehydes	0.25			mg	Air	
Notes: ''Aromatic-HC'', unspecified	Output	Emission	Aromatics	7			mg	Air	
Notes: ''Arsenic'', <0.5 mg	Output	Emission	As	0.25			mg	Water	
Notes: ''BOD'', biochemical oxygen demand	Output	Emission	BOD	8			mg	Water	
Notes: ''Ca++'', <0.5 mg	Output	Emission	Ca	0.25			mg	Water	
Notes: ''CFC/HCFC'', unspecified	Output	Emission	CFCs/HCFCs	1			mg	Air	
Notes: ''Organo-Cl'', unspecified, <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Air	
Notes: ''Organo-chlorine'', <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Water	
Notes: ''Cl-''	Output	Emission	Cl-	240			mg	Water	
Notes: ''Dissolved Cl2'', <0.5 mg	Output	Emission	Cl2	0.25			mg	Water	
Notes: ''Cl2'', <0.5 mg	Output	Emission	Cl2	0.25			mg	Air	
Notes: ''CN-'', <0.5 mg	Output	Emission	CN-	0.25			mg	Water	
Notes: ''CO''	Output	Emission	CO	890			mg	Air	

Method: CO2, unlike other emissions, is not measured but calculated from the amounts of combusted fuels. The amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes. CO2 emission from use of biomass has been subtracted from the total. Notes: ''CO2''	Output	Emission	CO2	1.4			kg	Air	
Notes: ''CO3--''	Output	Emission	CO32-	220			mg	Water	
Notes: ''COD'', chemical oxygen demand	Output	Emission	COD	250			mg	Water	
Notes: ''CrO3'', <0.5 mg, which corresponds to <0.25 mg Cr(VI), as there is 52% Cr in CrO3.	Output	Emission	Cr(VI)	0.13			mg	Water	
Notes: ''CS2'', <0.5 mg	Output	Emission	CS2	0.25			mg	Air	
Notes: ''Cu+/Cu++'', <0.5 mg	Output	Emission	Cu	0.25			mg	Water	
Notes: ''Dissolved organics'', unspecified	Output	Emission	Dissolved organics	23			mg	Water	
Notes: ''Dissolved solids'', unspecified	Output	Emission	Dissolved solids	60			mg	Water	
Notes: ''F-'', <0.5 mg	Output	Emission	F-	0.25			mg	Water	
Notes: ''F2'', <0.5 mg	Output	Emission	F2	0.25			mg	Air	
Notes: ''Fe++/Fe+++'', <0.5 mg	Output	Emission	Fe	0.25			mg	Water	
Notes: ''Hydrogen (H2)''	Output	Emission	H2	13			mg	Air	
Notes: ''H2S''	Output	Emission	H2S	1			mg	Air	
Notes: ''H2SO4'', <0.5 mg	Output	Emission	H2SO4	0.25			mg	Air	
Notes: ''HCl''	Output	Emission	HCl	12			mg	Air	
Notes: ''HCN'', <0.5 mg	Output	Emission	HCN	0.25			mg	Air	
Notes: ''HF'', <0.5 mg	Output	Emission	HF	0.25			mg	Air	
Notes: ''Mercury (Hg)'', <0.5 mg	Output	Emission	Hg	0.25			mg	Air	
Notes: ''Hg'', <0.5 mg	Output	Emission	Hg	0.25			mg	Water	
Notes: ''Hydrocarbons'', unspecified	Output	Emission	Hydrocarbons	3			g	Air	
Notes: ''Hydrocarbons'', unspecified	Output	Emission	Hydrocarbons	47			mg	Water	
Notes: ''K+'', <0.5 mg	Output	Emission	K	0.25			mg	Water	
Notes: ''Metals'', unspecified	Output	Emission	Metals	1			mg	Air	
Notes: ''Metals - unspecified''	Output	Emission	Metals	610			mg	Water	
Notes: ''Methane''	Output	Emission	Methane	4.5			g	Air	
Notes: ''Mg++'', <0.5 mg	Output	Emission	Mg	0.25			mg	Water	
Notes: ''Other nitrogen''	Output	Emission	N total	4			mg	Water	
Notes: ''N2O'', <0.5 mg	Output	Emission	N2O	0.25			mg	Air	
Notes: ''Na+''	Output	Emission	Na	36			mg	Water	
Notes: ''Ammonia (NH3)'', <0.5 mg	Output	Emission	NH3	0.25			mg	Air	
Notes: ''NH4''	Output	Emission	NH4+	1			mg	Water	
Notes: ''Ni++'', <0.5 mg	Output	Emission	Ni	0.25			mg	Water	
Notes: ''NO3-'', <0.5 mg	Output	Emission	NO3-	0.25			mg	Water	
Notes: ''NOx''	Output	Emission	NOx	5.6			g	Air	
Notes: ''Detergent/oil'', unspecified	Output	Emission	Oil	51			mg	Water	
Notes: ''Other organics''	Output	Emission	Organics	1			mg	Water	
Notes: ''Other organics'', unspecified	Output	Emission	Organics	1			mg	Air	
Notes: ''Polycyclic-HC'', <0.5 mg	Output	Emission	PAH	0.25			mg	Air	
Notes: ''Dust''	Output	Emission	Particles	670			mg	Air	
Notes: ''Pb'', <0.5 mg	Output	Emission	Pb	0.25			mg	Water	
Notes: ''Lead (Pb)'', <0.5 mg	Output	Emission	Pb	0.25			mg	Air	
Notes: ''Phenol''	Output	Emission	Phenol	2			mg	Water	
Notes: ''Phosphate as P2O5'', 7 mg, which corresponds to 9.4 mg PO43- (1 g P2O5 corresponds to 1.34 g PO43-).	Output	Emission	PO43-	9.4			mg	Water	
Notes: ''Sulphur/sulphide'', <0.5 mg	Output	Emission	S2-	0.25			mg	Water	
Notes: ''SOx'', i.e. SO2 + SO3	Output	Emission	SO2	3			g	Air	
Notes: ''SO4--''	Output	Emission	SO42-	250			mg	Water	
Notes: ''Suspended solids''	Output	Emission	Suspended solids	240			mg	Water	
Notes: ''Mercaptans'', <0.5 mg	Output	Emission	Thiols	0.25			mg	Air	
Notes: ''VCM'', <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Water	
Notes: ''VCM'', <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Air	
Notes: ''Zn++'', <0.5 mg	Output	Emission	Zn	0.25			mg	Water	

Notes: ''Polyethylene resin (linear low density)'', linear low density polyethylene (LLDPE)	Output	Product	Polyethylene LD	1			kg	Technosphere	
Notes: ''Inert chemical''	Output	Residue	Inert chemical waste	1.4			g	Technosphere	
Notes: ''Mineral''	Output	Residue	Mineral waste	6.4			g	Technosphere	
Notes: Aggregation of different wastes: ''Mixed industrial'', 410 mg ''Unspecified'', 4 mg ''Construction'', 9 mg ''Metals'', 3 mg ''Paper & board'', <1 mg ''Wood waste'', <1 mg	Output	Residue	Mixed industrial waste	430			mg	Technosphere	
Notes: ''Plastics''	Output	Residue	Plastics waste	2			mg	Technosphere	
Notes: ''Regulated chemical''	Output	Residue	Regulated chemical waste	240			mg	Technosphere	
Notes: ''Slags/ash''	Output	Residue	Slags and ash	1.6			g	Technosphere	
Notes: ''To incinerator''	Output	Residue	Waste to incineration	660			mg	Technosphere	
Notes: ''To recycling''	Output	Residue	Waste to recycling	6			mg	Technosphere	

About Inventory	
Publication	''Eco-profiles of the European plastics industry'', reports for linear low density polyethylene (LLDPE), ethylene and naphtha. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe) The APME project co-ordinator: Vince Matthews. The members of the original independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom. -- Editor: Data were entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 2001-05-30. Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 29 October 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as building blocks for use in the construction of complete life cycle analyses. 1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies. - Internal company benchmarking. - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occurred since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows.

	Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for linear low density polyethylene production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data on the LLDPE production processes have been supplied by 3 plants in 2 European countries. It is not known how representative data are for production of LLDPE in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Note that emissions <0.5 mg (0.25 mg in data table) may be far below 0.5 mg in some cases. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, data for each production sequence (i.e. each plant + its specific suppliers) are calculated separately. The final result is the average of the results from the individual production sequences weighted by the output from each sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission (kg/MJ fuel) = 3.67 x {mass fraction of carbon in fuel}/{calorific value of fuel}. The following interpretations/changes from the original report have been made by Gunnar Mattson, ABB Corporate Research: - Nuclear energy has been recalculated to natural uranium resource. - Ferromanganese, Phosphate and Rutile have been recalculated to the corresponding amounts of Mn, P and Ti resources. - The energy resources Hydrogen and Sulphur have been excluded, as these parameters do not represent true natural resources. - Emissions and resources <0.5 mg (<1 mg in the Eco-profiles result tables) are presented as 0.25 mg, i.e. 1/2 of the ''<'' value. This is in accordance with common statistical procedure.
Notes	

SPINE LCI dataset: Extraction to SAN APME

Administrative	
Finished	Y
Date Completed	1999

Copyright	APME
Availability	Public

Technical System

Name	Extraction to SAN APME
Functional Unit	1 kg of SAN (styrene-acrylonitrile copolymer)
Functional Unit Explanation	SAN is a copolymer of styrene (C6H5-CH=CH2) and acrylonitrile (CH2=CH-CN. Typical uses of SAN: kitchen appliances, refrigerator inner parts, food containers, lighting and glazing parts, blend polymer with polybutadiene in ABS.
Process Type	Cradle to gate
Site	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	Production of SAN (styrene-acrylonitrile copolymer) including all major operations from extraction of crude oil and gas to polymerisation. SAN is produced in the same production sequence as ABS (acrylonitrile-butadiene-styrene copolymer), which means that the technical system is similar. According to a schematic flow diagram in the ''Eco-profiles...'' report, the following sub-processes are included: - Cracking of naphtha and/or natural gas for ethylene, propylene and butenes. - Styrene production: Reforming of naphtha for benzene + production of benzene from cracking products (''pygas'') in an aromatics plant, ethylene from cracker, ethylbenzene production, styrene production. - Acrylonitrile production: Propylene from cracker, production of ammonia from natural gas and air, production of acrylonitrile from ammonia and propylene. - SAN production from styrene and acrylonitrile. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and delivery; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been traced back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 3 plants in 2 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. Some more information about the processes are found in the ''Eco-profiles...'' reports for SAN (styrene-acrylonitrile copolymer), naphtha and the other intermediates, and the Methodology report, which are available at APME''s web site http://lca.apme.org.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available.'' Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under their specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment. Emissions <0.5 mg were presented as <1 mg in the Eco-profiles result tables. In this activity, however, they are presented as 0.25 mg (1/2 of the maximum value 0.5 mg). Note that the actual values may be far below 0.5 mg in some cases. The energy resources Hydrogen and Sulphur have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy

	equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table.
Time Boundary	Data refer to the years 1994 to 1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data for 3 SAN production plants that produced 115 000 tonnes (unknown fraction of the total European production). Data were supplied by 3 plants in 2 countries: Germany and Netherlands. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates. For the intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides that plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included.) - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most other cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0.01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Methodology report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g., sulphuric acid is used as a drying agent for chlorine; therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity.
Systems Expansions	Not applied. The amount of Recovered energy is reported as a negative primary energy equivalent input.

Flow Data

General Activity QMetaData

Date Conceived	1994 to 1995
Data Type	Derived, mixed
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	European average data. Results are based on data supplied by 3 production plants in 2 countries: Germany and Netherlands. Their total production was 115 000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each

	plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. Emissions and resources <0.5 mg have been assumed by Gunnar Mattson, ABB Corporate research (GM) to be 0.25 mg, i.e. half the ''<'' values given, which is in accordance with common statistical procedure. The energy resources Hydrogen (0.11 MJ) and Sulphur (0.02 MJ) have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table. 2001-06-18 SECRC/GM
Literature Reference	''Eco-profiles of the European plastics industry'', report for SAN (styrene-acrylonitrile copolymer), naphtha and the other intermediates. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe)
Notes	In the result tables in the ''Eco-profiles...'' report, not only total fuels and feedstocks, emissions to air and water, and solid waste are presented, but also the amounts caused by fuel production, fuel use, transport, feedstock (only for fuels and feedstocks) and processes. As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field. Please note: Some other interpretations/changes have been made from the original report by Gunnar Mattson, ABB Corporate Research. See Method and AboutData for details.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: ''air'', compressed air	Input	Natural resource	Air	190			g	Ground	
Notes: ''barytes'', <0.5 mg	Input	Natural resource	Barytes	0.25			mg	Ground	
Notes: ''bauxite''	Input	Natural resource	Bauxite	670			mg	Ground	
Notes: ''bentonite''	Input	Natural resource	Bentonite	220			mg	Ground	
Notes: ''Biomass''	Input	Natural resource	Biomass	710			mg	Ground	
Notes: ''rutile''	Input	Natural resource	CaSO4	22			mg	Ground	
Notes: ''chalk'', <0.5 mg	Input	Natural resource	Chalk	0.25			mg	Ground	
Notes: ''chromium'', <0.5 mg	Input	Natural resource	Chromium in ore	0.25			mg	Ground	
Notes: ''clay''	Input	Natural resource	Clay	16			mg	Ground	
Notes: ''Crude oil'', gross primary fuel and/or feedstock resource, 680 g or 30.8 MJ.	Input	Natural resource	Crude oil	680			g	Ground	
Notes: ''dolomite''	Input	Natural resource	Dolomite	10			mg	Ground	
Notes: ''feldspar'', <0.5 mg	Input	Natural resource	Feldspar	0.25			mg	Ground	
Notes: ''fluorspar''	Input	Natural resource	Fluorspar	4			mg	Ground	
Notes: ''granite'', <0.5 mg	Input	Natural resource	Granite	0.25			mg	Ground	
Notes: ''gravel''	Input	Natural resource	Gravel	3			mg	Ground	
Notes: ''Coal'', gross primary fuel and/or feedstock resource, 71 g or 1.98 MJ. 320 mg ''Metallurgical coal'' is included.	Input	Natural resource	Hard coal	71			g	Ground	
Notes: ''Hydro'', gross primary energy equivalent (80% electricity production efficiency has been assumed in APME reports).	Input	Natural resource	Hydro energy	0.14			MJ	Ground	
Notes: ''iron''	Input	Natural resource	Iron in ore	880			mg	Ground	

Notes: ''potassium chloride''	Input	Natural resource	KCl	4			mg	Ground	
Notes: ''lead''	Input	Natural resource	Lead in ore	1			mg	Ground	
Notes: ''Lignite'', gross primary fuel and/or feedstock resource, 48 g or 0.72 MJ.	Input	Natural resource	Lignite	48			g	Ground	
Notes: ''limestone''	Input	Natural resource	Limestone	1.8			g	Ground	
Method: ''ferromanganese'', 1 mg. It was assumed by SECRC/GM that the ferromanganese contained 80% Mn. Notes: ''ferromanganese''	Input	Natural resource	Manganese in ore	0.8			mg	Ground	
Notes: ''nitrogen''	Input	Natural resource	N2	47			g	Ground	
Notes: ''sodium chloride''	Input	Natural resource	NaCl	2.2			g	Ground	
Notes: ''Gas/condensate'' (natural gas), gross primary fuel and/or feedstock resource, 1200 g or 60.3 MJ.	Input	Natural resource	Natural gas	1.2			kg	Ground	
Notes: ''nickel'', <0.5 mg	Input	Natural resource	Nickel in ore	0.25			mg	Ground	
Notes: ''oxygen''	Input	Natural resource	O2	43			mg	Ground	
Notes: ''olivine''	Input	Natural resource	Olivine	7			mg	Ground	
Notes: ''Peat''	Input	Natural resource	Peat	14			mg	Ground	
Method: ''phosphate as P2O5'', <0.5 mg, which corresponds to <0.2 mg P (44% P in P2O5). Notes: ''phosphate as P2O5''	Input	Natural resource	Phosphorus in ore	0.11			mg	Ground	
Notes: ''sand''	Input	Natural resource	Sand	110			mg	Ground	
Notes: ''shale''	Input	Natural resource	Shale	62			mg	Ground	
Notes: ''sulphur (bonded)'', 1.3 g + ''sulphur (elemental)'', 2.7 g	Input	Natural resource	Sulphur in ore	4			g	Ground	
Method: ''rutile'', <0.5 mg, which should correspond to <0.3 mg Ti, assuming that the rutile (TiO2) mineral contained 60% Ti.	Input	Natural resource	Titanium in ore	0.15			mg	Ground	
Notes: ''Unspecified'', gross primary fuel and/or feedstock	Input	Natural resource	Unspecified energy	0.08			MJ	Ground	
Data type: Derived, mixed Method: ''Nuclear'' energy, 1.15 MJ, gross primary energy equivalent (35% electricity production efficiency has been assumed in APME reports). 35% efficiency [1] and 7.85 mg uranium resource/MJ electricity [2] are assumed by SECRC/GM, i.e. 1.15 MJ Nuclear energy should correspond to 1.15*0.35*7.85=3.16 mg of natural uranium (U) resource. 2001-06-18 SECRC/GM Literature: [1] ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. [2] ''Oekoinventare von Energiesystemen'', R. Frischknecht & al, ETH, 1996. Notes: ''Nuclear''	Input	Natural resource	Uranium in ore	3.16			mg	Ground	
Notes: ''Gross water resources'', total. Aggregation of different sources: ''Public supply'', 4.7 kg ''River/canal'', 27 kg ''Sea'', 119 kg ''Unspecified'', 18 kg ''Well'', 100 g 6.1 kg of the water is used for processing, 163 kg for cooling.	Input	Natural resource	Water	169			kg	Ground	
Notes: ''Wood''	Input	Natural resource	Wood	3			mg	Ground	
Notes: ''zinc'', <0.5 mg	Input	Natural resource	Zinc in ore	0.25			mg	Ground	

Notes: ''Recovered energy'', gross primary energy equivalent	Input	Refined resource	Recovered energy	-5.93			MJ	Technosphere	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Water	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Air	
Notes: ''Acid (H+)''	Output	Emission	Acid as H+	44			mg	Water	
Notes: ''Al+++''	Output	Emission	Al	120			mg	Water	
Notes: ''Aldehydes (CHO)'', unspecified, <0.5 mg	Output	Emission	Aldehydes	0.25			mg	Air	
Notes: ''Aromatic-HC'', unspecified	Output	Emission	Aromatics	95			mg	Air	
Notes: ''Arsenic'', <0.5 mg	Output	Emission	As	0.25			mg	Water	
Notes: ''BOD'', biochemical oxygen demand	Output	Emission	BOD	18			mg	Water	
Notes: ''Ca++''	Output	Emission	Ca	1			mg	Water	
Notes: ''CFC/HCFC'', unspecified	Output	Emission	CFCs/HCFCs	2			mg	Air	
Notes: ''Organo-chlorine'', <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Water	
Notes: ''Organo-Cl'', unspecified, <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Air	
Notes: ''Cl-''	Output	Emission	Cl-	2.7			g	Water	
Notes: ''Cl2'', <0.5 mg	Output	Emission	Cl2	0.25			mg	Air	
Notes: ''Dissolved Cl2'', <0.5 mg	Output	Emission	Cl2	0.25			mg	Water	
Notes: ''CN-''	Output	Emission	CN-	14			mg	Water	
Notes: ''CO''	Output	Emission	CO	3.8			g	Air	
Method: CO2, unlike other emissions, is not measured but calculated from the amounts of combusted fuels. The amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes. CO2 emission from use of biomass has been subtracted from the total. Notes: ''CO2''	Output	Emission	CO2	2.8			kg	Air	
Notes: ''CO3--''	Output	Emission	CO32-	190			mg	Water	
Notes: ''COD'', chemical oxygen demand	Output	Emission	COD	1.2			g	Water	
Notes: ''CrO3'', <0.5 mg, which corresponds to <0.26 mg Cr(VI), as there is 52% Cr in CrO3.	Output	Emission	Cr(VI)	0.13			mg	Water	
Notes: ''CS2'', <0.5 mg	Output	Emission	CS2	0.25			mg	Air	
Notes: ''Cu+/Cu++'', <0.5 mg	Output	Emission	Cu	0.25			mg	Water	
Notes: ''Dissolved organics'', unspecified	Output	Emission	Dissolved organics	30			mg	Water	
Notes: ''Dissolved solids'', unspecified	Output	Emission	Dissolved solids	980			mg	Water	
Notes: ''F-'', <0.5 mg	Output	Emission	F-	0.25			mg	Water	
Notes: ''F2'', <0.5 mg	Output	Emission	F2	0.25			mg	Air	
Notes: ''Fe++/Fe+++'', <0.5 mg	Output	Emission	Fe	0.25			mg	Water	
Notes: ''Hydrogen (H2)''	Output	Emission	H2	87			mg	Air	
Notes: ''H2S''	Output	Emission	H2S	2			mg	Air	
Notes: ''H2SO4'', <0.5 mg	Output	Emission	H2SO4	0.25			mg	Air	
Notes: ''HCl''	Output	Emission	HCl	33			mg	Air	
Notes: ''HCN'', <0.5 mg	Output	Emission	HCN	0.25			mg	Air	
Notes: ''HF''	Output	Emission	HF	2			mg	Air	
Notes: ''Hg'', <0.5 mg	Output	Emission	Hg	0.25			mg	Water	
Notes: ''Mercury (Hg)'', <0.5 mg	Output	Emission	Hg	0.25			mg	Air	
Notes: ''Hydrocarbons'', unspecified	Output	Emission	Hydrocarbons	3.4			g	Air	
Notes: ''Hydrocarbons'', unspecified	Output	Emission	Hydrocarbons	67			mg	Water	
Notes: ''K+'', <0.5 mg	Output	Emission	K	0.25			mg	Water	
Notes: ''Metals'', unspecified	Output	Emission	Metals	3			mg	Air	
Notes: ''Metals - unspecified''	Output	Emission	Metals	480			mg	Water	
Notes: ''Methane''	Output	Emission	Methane	9			g	Air	
Notes: ''Mg++'', <0.5 mg	Output	Emission	Mg	0.25			mg	Water	
Notes: ''Other nitrogen''	Output	Emission	N total	130			mg	Water	
Notes: ''N2O'', <0.5 mg	Output	Emission	N2O	0.25			mg	Air	
Notes: ''Na+''	Output	Emission	Na	720			mg	Water	
Notes: ''Ammonia (NH3)''	Output	Emission	NH3	3			mg	Air	
Notes: ''NH4''	Output	Emission	NH4+	410			mg	Water	
Notes: ''Ni++'', <0.5 mg	Output	Emission	Ni	0.25			mg	Water	

Notes: ''NO3-''	Output	Emission	NO3-	2			mg	Water	
Notes: ''NOx''	Output	Emission	NOx	9.2			g	Air	
Notes: ''Detergent/oil'', unspecified	Output	Emission	Oil	69			mg	Water	
Notes: ''Other organics''	Output	Emission	Organics	2			mg	Water	
Notes: ''Other organics'', unspecified	Output	Emission	Organics	88			mg	Air	
Notes: ''Polycyclic-HC'', <0.5 mg	Output	Emission	PAH	0.25			mg	Air	
Notes: ''Dust''	Output	Emission	Particles	1.7			g	Air	
Notes: ''Pb'', <0.5 mg	Output	Emission	Pb	0.25			mg	Water	
Notes: ''Lead (Pb)'', <0.5 mg	Output	Emission	Pb	0.25			mg	Air	
Notes: ''Phenol''	Output	Emission	Phenol	3			mg	Water	
Notes: ''Phosphate as P2O5'', 1 mg, which corresponds to 1.3 mg PO43- (1 g P2O5 corresponds to 1.34 g PO43-).	Output	Emission	PO43-	1.3			mg	Water	
Notes: ''Sulphur/sulphide''	Output	Emission	S2-	1			mg	Water	
Notes: ''SOx'', i.e. SO2 + SO3	Output	Emission	SO2	7.5			g	Air	
Notes: ''SO4--''	Output	Emission	SO42-	1.1			g	Water	
Notes: ''Suspended solids''	Output	Emission	Suspended solids	320			mg	Water	
Notes: ''Mercaptans'', <0.5 mg	Output	Emission	Thiols	0.25			mg	Air	
Notes: ''VCM'', <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Water	
Notes: ''VCM'', <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Air	
Notes: ''Zn++'', <0.5 mg	Output	Emission	Zn	0.25			mg	Water	
Notes: ''SAN'', i.e. styrene-acrylonitrile copolymer	Output	Product	SAN	1			kg	Technosphere	
Notes: ''Inert chemical''	Output	Residue	Inert chemical waste	1.1			g	Technosphere	
Notes: ''Mineral''	Output	Residue	Mineral waste	24			g	Technosphere	
Notes: Aggregation of different wastes: ''Mixed industrial'', 1.1 g ''Unspecified'', 19 mg ''Construction'', 24 mg ''Metals'', 9 mg ''Paper & board'', <0.5 mg ''Wood waste'', <0.5 mg	Output	Residue	Mixed industrial waste	1.15			g	Technosphere	
Notes: ''Plastics''	Output	Residue	Plastics waste	6			mg	Technosphere	
Notes: ''Regulated chemical''	Output	Residue	Regulated chemical waste	4.1			g	Technosphere	
Notes: ''Slags/ash''	Output	Residue	Slags and ash	5.3			g	Technosphere	
Notes: ''To incinerator''	Output	Residue	Waste to incineration	4			g	Technosphere	
Notes: ''To recycling''	Output	Residue	Waste to recycling	58			mg	Technosphere	

About Inventory

Publication	''Eco-profiles of the European plastics industry'', reports for SAN (styrene-acrylonitrile copolymer), naphtha and the other intermediates. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe) The APME project co-ordinator: Vince Matthews. The members of the original independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom. -- Editor: Data were entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 2001-06-18. Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 29 October 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as building blocks for use in the construction of complete life cycle analyses. 1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging

	manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies. - Internal company benchmarking. - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occurred since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for SAN production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data on the SAN production processes have been supplied by 3 plants in 2 European countries. Data are probably fairly representative for production of SAN in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Note that emissions <0.5 mg (0.25 mg in data table) may be far below 0.5 mg in some cases. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, data for each production sequence (i.e. each plant + its specific suppliers) are calculated separately. The final result is the average of the results from the individual production sequences weighted by the output from each sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission (kg/MJ fuel) = 3.67 x {mass fraction of carbon in fuel}/{calorific value of fuel}. The following interpretations/changes from the original report have been made by Gunnar Mattson, ABB Corporate Research: - Nuclear energy has been recalculated to natural uranium resource. - Ferromanganese, Phosphate and Rutile have been recalculated to the corresponding amounts

	of Mn, P and Ti resources. - The energy resources Hydrogen and Sulphur have been excluded, as these parameters do not represent true natural resources. - Emissions and resources <0.5 mg (<1 mg in the Eco-profiles result tables) are presented as 0.25 mg, i.e. 1/2 of the ''<'' value. This is in accordance with common statistical procedure.
Notes	-- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 29 October 2001 <<< Changes made by Gunnar Mattson, ABB Corporate Research: The general documentation of the data have been supplemented to improve the transparency and the consistency with other published data sets from the APME reports. The earlier published edition of the data set were named ''Production of SAN co-polymer granules'', and were documented by Sofia Medin, Electrolux Research and Innovation AB.

SPINE LCI dataset: Extraction to toluene APME

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Extraction to toluene APME
Functional Unit	1 kg of toluene
Functional Unit Explanation	Toluene, C6H5CH3, is an organic compound, liquid at room temperature. It is used as a solvent, in benzene production, and in TDI production (TDI is an intermediate in polyurethane production).
Process Type	Cradle to gate
Site	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	Production of toluene including all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. Most toluene is produced directly from naphtha by catalytic reforming, a process in which naphthenic compounds in naphtha are dehydrogenated. The basic feedstock is thus converted into a mixture of products, mainly benzene, toluene and xylene; hence, the process is often called the BTX process. Benzene and the other aromatics are isolated in the pure state from the output of the reformer by solvent extraction and fractional distillation. The output of toluene is maximised if the naphtha feed is rich in ring compounds containing 7 carbon atoms. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and delivery; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been traced back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 10 plants in 4 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. Some more information about the processes are found in the ''Eco-profiles...'' reports for toluene and naphtha, and the Methodology report, which are available at APME''s web site http://lca.apme.org.

System Boundaries	
Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available.'' Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under their specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment. Emissions <0.5 mg were presented as <1 mg in the Eco-profiles result tables. In this activity, however, they are presented as 0.25 mg (1/2 of the maximum value 0.5 mg). Note that the actual values may be far below 0.5 mg in some cases. The energy resources Hydrogen and Sulphur have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table.
Time Boundary	Data refer to the years 1990-96. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data for toluene production plants that produced 1,2 million tonnes. Data were supplied by 10 plants in 4 countries: Belgium, Germany, Italy and Netherlands. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For the intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides that plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included.) - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most other cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0.01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Methodology report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g., sulphuric acid is used as a drying agent for chlorine; therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process.

	- Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity.
Systems Expansions	Not applied. The amount of Recovered energy is reported as a negative primary energy equivalent input.

Flow Data

General Activity QMetaData

Date Conceived	1990 to 1996
Data Type	Derived, mixed
Represents	As no data for extraction of dolomite in Norway was obtained, figures from Swedish extraction of dolomite has been used.
Method	European average data. Results are based on data supplied by 10 production plants in 4 countries: Belgium, Germany, Italy and Netherlands. Their total production was 1.2 million tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. Emissions and resources <0.5 mg have been assumed by Gunnar Mattson, ABB Corporate Research (GM) to be 0.25 mg, i.e. half the ''<'' values given, which is in accordance with common statistical procedure. The energy resources Hydrogen (0.07 MJ) and Sulphur (<0.01 MJ) have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table. 2001-01-19 SECRC/GM
Literature Reference	''Eco-profiles of the European plastics industry'', reports for toluene and naphtha. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe)
Notes	In the result tables in the ''Eco-profiles...'' report, not only total fuels and feedstocks, emissions to air and water, and solid waste are presented, but also the amounts caused by fuel production, fuel use, transport, feedstock (only for fuels and feedstocks) and processes. As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field. Please note: Some other interpretations/changes have been made from the original report by Gunnar Mattson, ABB Corporate Research. See Method and AboutData for details.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: ''air'', compressed air	Input	Natural resource	Air	60			g	Ground	
Notes: ''barytes'', <0.5 mg	Input	Natural resource	Barytes	0.25			mg	Ground	
Notes: ''bauxite''	Input	Natural resource	Bauxite	850			mg	Ground	
Notes: ''bentonite''	Input	Natural resource	Bentonite	200			mg	Ground	
Notes: ''Biomass''	Input	Natural resource	Biomass	310			mg	Ground	
Notes: ''calcium sulphate''	Input	Natural resource	CaSO4	20			mg	Ground	
Notes: ''chalk'', <0.5 mg	Input	Natural resource	Chalk	0.25			mg	Ground	
Notes: ''chromium'', <0.5 mg	Input	Natural resource	Chromium in ore	0.25			mg	Ground	
Notes: ''clay''	Input	Natural resource	Clay	13			mg	Ground	

Notes: ''Crude oil'', gross primary fuel and/or feedstock resource, 640 g or 28.74 MJ.	Input	Natural resource	Crude oil	640			g	Ground	
Notes: ''dolomite''	Input	Natural resource	Dolomite	8			mg	Ground	
Notes: ''feldspar'', <0.5 mg	Input	Natural resource	Feldspar	0.25			mg	Ground	
Notes: ''fluorspar''	Input	Natural resource	Fluorspar	8			mg	Ground	
Notes: ''granite'', <0.5 mg	Input	Natural resource	Granite	0.25			mg	Ground	
Notes: ''gravel''	Input	Natural resource	Gravel	2			mg	Ground	
Notes: ''Coal'', gross primary fuel and/or feedstock resource, 25 g or 0.69 MJ. 270 mg ''Metallurgical coal'' is included.	Input	Natural resource	Hard coal	25			g	Ground	
Notes: ''Hydro'', gross primary energy equivalent (80% electricity production efficiency has been assumed in APME reports).	Input	Natural resource	Hydro energy	0.03			MJ	Ground	
Notes: ''iron''	Input	Natural resource	Iron in ore	740			mg	Ground	
Notes: ''potassium chloride''	Input	Natural resource	KCl	1			mg	Ground	
Notes: ''lead'', <0.5 mg	Input	Natural resource	Lead in ore	0.25			mg	Ground	
Notes: ''Lignite'', gross primary fuel and/or feedstock resource, 2.4 g or 0.04 MJ.	Input	Natural resource	Lignite	2.4			g	Ground	
Notes: ''limestone''	Input	Natural resource	Limestone	810			mg	Ground	
Method: ''ferromanganese'', 1 mg. It was assumed by SECRC/GM that the ferromanganese contained 80% Mn. Notes: ''ferromanganese''	Input	Natural resource	Manganese in ore	0.8			mg	Ground	
Notes: ''nitrogen''	Input	Natural resource	N2	20			g	Ground	
Notes: ''sodium chloride''	Input	Natural resource	NaCl	1.7			g	Ground	
Notes: ''Gas/condensate'' (natural gas), gross primary fuel and/or feedstock resource, 900 g or 45.31 MJ.	Input	Natural resource	Natural gas	900			g	Ground	
Notes: ''nickel'', <0.5 mg	Input	Natural resource	Nickel in ore	0.25			mg	Ground	
Notes: ''oxygen''	Input	Natural resource	O2	29			mg	Ground	
Notes: ''olivine''	Input	Natural resource	Olivine	6			mg	Ground	
Notes: ''Peat''	Input	Natural resource	Peat	1			mg	Ground	
Method: ''phosphate as P2O5'', <0.5 mg, which corresponds to <0.22 mg P (44% P in P2O5). Notes: ''phosphate as P2O5'',	Input	Natural resource	Phosphorus in ore	0.11			mg	Ground	
Notes: ''sand''	Input	Natural resource	Sand	82			mg	Ground	
Notes: ''shale''	Input	Natural resource	Shale	58			mg	Ground	
Notes: ''sulphur (bonded)'', 13 mg + ''sulphur (elemental)'', 39 mg	Input	Natural resource	Sulphur in ore	52			mg	Ground	
Method: ''rutile'', <0.5 mg, which should correspond to <0.3 mg Ti, assuming that the rutile (TiO2) mineral contained 60% Ti. Notes: ''rutile''	Input	Natural resource	Titanium in ore	0.15			mg	Ground	
Notes: ''Unspecified'', gross primary fuel and/or feedstock	Input	Natural resource	Unspecified energy	0.01			MJ	Ground	
Data type: Derived, mixed Method: ''Nuclear'' energy, 0.53 MJ, gross primary energy equivalent (35% electricity production efficiency has been assumed in APME reports). 35% efficiency [1] and 7.85 mg uranium resource/MJ electricity [2] are assumed by GM, i.e. 0.53 MJ Nuclear	Input	Natural resource	Uranium in ore	1.5			mg	Ground	

energy should correspond to 0.53*0.35*7.85=1.5 mg of natural uranium (U) resource. 2001-01-19 SECRC/GM Literature: [1] "Eco-profiles of plastics and related intermediates: Methodology", I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. [2] "Oekoinventare von Energiesystemen", R. Frischknecht & al, ETH, 1996. Notes: "Nuclear"									
Notes: "Gross water resources", total. Aggregation of different sources: "Public supply", 2.3 kg "River/canal", 84 g "Sea", 105 kg "Unspecified", 22 kg "Well", 1.3 g 2.5 kg of the water is used for processing, 126 kg for cooling.	Input	Natural resource	Water	129			kg	Ground	
Notes: "Wood"	Input	Natural resource	Wood	1			mg	Ground	
Notes: "zinc", <0.5 mg	Input	Natural resource	Zinc in ore	0.25			mg	Ground	
Notes: "Recovered energy", gross primary energy equivalent	Input	Refined resource	Recovered energy	-2.75			MJ	Technosphere	
Notes: "DCE", <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Water	
Notes: "DCE", <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Air	
Notes: "Acid (H+)"	Output	Emission	Acid as H+	37			mg	Water	
Notes: "Al+++"	Output	Emission	Al	51			mg	Water	
Notes: "Aldehydes (CHO)", unspecified, <0.5 mg	Output	Emission	Aldehydes	0.25			mg	Air	
Notes: "Aromatic-HC", unspecified	Output	Emission	Aromatics	67			mg	Air	
Notes: "Arsenic", <0.5 mg	Output	Emission	As	0.25			mg	Water	
Notes: "BOD", biochemical oxygen demand	Output	Emission	BOD	12			mg	Water	
Notes: "Ca++", <0.5 mg	Output	Emission	Ca	0.25			mg	Water	
Notes: "CFC/HCFC", unspecified	Output	Emission	CFCs/HCFCs	1			mg	Air	
Notes: "Organo-Cl", unspecified, <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Air	
Notes: "Organo-chlorine", <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Water	
Notes: "Cl-"	Output	Emission	Cl-	1.2			g	Water	
Notes: "Dissolved Cl2", <0.5 mg	Output	Emission	Cl2	0.25			mg	Water	
Notes: "Cl2", <0.5 mg	Output	Emission	Cl2	0.25			mg	Air	
Notes: "CN-", <0.5 mg	Output	Emission	CN-	0.25			mg	Water	
Notes: "CO"	Output	Emission	CO	1.1			g	Air	
Method: CO2, unlike other emissions, is not measured but calculated from the amounts of combusted fuels. The amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes. CO2 emission from use of biomass has been subtracted from the total. Notes: "CO2"	Output	Emission	CO2	1.5			kg	Air	
Notes: "CO3--"	Output	Emission	CO32-	180			mg	Water	
Notes: "COD", chemical oxygen demand	Output	Emission	COD	280			mg	Water	
Notes: "CrO3", <0.5 mg, which corresponds to <0.26 mg Cr(VI), as there is 52% Cr in CrO3.	Output	Emission	Cr(VI)	0.13			mg	Water	
Notes: "CS2", <0.5 mg	Output	Emission	CS2	0.25			mg	Air	
Notes: "Cu+/Cu++", <0.5 mg	Output	Emission	Cu	0.25			mg	Water	
Notes: "Dissolved organics", unspecified	Output	Emission	Dissolved organics	22			mg	Water	
Notes: "Dissolved solids", unspecified	Output	Emission	Dissolved solids	81			mg	Water	
Notes: "F-", <0.5 mg	Output	Emission	F-	0.25			mg	Water	
Notes: "F2", <0.5 mg	Output	Emission	F2	0.25			mg	Air	
Notes: "Fe++/Fe+++", <0.5 mg	Output	Emission	Fe	0.25			mg	Water	
Notes: "Hydrogen (H2)"	Output	Emission	H2	58			mg	Air	

Notes: "H2S", <0.5 mg	Output	Emission	H2S	0.25			mg	Air	
Notes: "H2SO4", <0.5 mg	Output	Emission	H2SO4	0.25			mg	Air	
Notes: "HCl"	Output	Emission	HCl	13			mg	Air	
Notes: "HCN", <0.5 mg	Output	Emission	HCN	0.25			mg	Air	
Notes: "HF", <0.5 mg	Output	Emission	HF	0.25			mg	Air	
Notes: "Mercury (Hg)", <0.5 mg	Output	Emission	Hg	0.25			mg	Air	
Notes: "Hg", <0.5 mg	Output	Emission	Hg	0.25			mg	Water	
Notes: "Hydrocarbons", unspecified	Output	Emission	Hydrocarbons	2			g	Air	
Notes: "Hydrocarbons", unspecified	Output	Emission	Hydrocarbons	38			mg	Water	
Notes: "K+", <0.5 mg	Output	Emission	K	0.25			mg	Water	
Notes: "Metals", unspecified	Output	Emission	Metals	2			mg	Air	
Notes: "Metals - unspecified"	Output	Emission	Metals	480			mg	Water	
Notes: "Methane"	Output	Emission	Methane	5			g	Air	
Notes: "Mg++", <0.5 mg	Output	Emission	Mg	0.25			mg	Water	
Notes: "Other nitrogen"	Output	Emission	N total	10			mg	Water	
Notes: "N2O", <0.5 mg	Output	Emission	N2O	0.25			mg	Air	
Notes: "Na+"	Output	Emission	Na	280			mg	Water	
Notes: "Ammonia (NH3)", <0.5 mg	Output	Emission	NH3	0.25			mg	Air	
Notes: "NH4"	Output	Emission	NH4+	3			mg	Water	
Notes: "Ni++", <0.5 mg	Output	Emission	Ni	0.25			mg	Water	
Notes: "NO3-"	Output	Emission	NO3-	5			mg	Water	
Notes: "NOx"	Output	Emission	NOx	6			g	Air	
Notes: "Detergent/oil", unspecified	Output	Emission	Oil	39			mg	Water	
Notes: "Other organics", <0.5 mg	Output	Emission	Organics	0.25			mg	Water	
Notes: "Other organics", unspecified	Output	Emission	Organics	1			mg	Air	
Notes: "Polycyclic-HC", <0.5 mg	Output	Emission	PAH	0.25			mg	Air	
Notes: "Dust"	Output	Emission	Particles	720			mg	Air	
Notes: "Pb", <0.5 mg	Output	Emission	Pb	0.25			mg	Water	
Notes: "Lead (Pb)", <0.5 mg	Output	Emission	Pb	0.25			mg	Air	
Notes: "Phenol"	Output	Emission	Phenol	1			mg	Water	
Notes: "Phosphate as P2O5", 1 mg, which corresponds to 1.3 mg PO43- (1 g P2O5 corresponds to 1.34 g PO43-).	Output	Emission	PO43-	1.3			mg	Water	
Notes: "Sulphur/sulphide", <0.5 mg	Output	Emission	S2-	0.25			mg	Water	
Notes: "SOx", i.e. SO2 + SO3	Output	Emission	SO2	4.2			g	Air	
Notes: "SO4--"	Output	Emission	SO42-	220			mg	Water	
Notes: "Suspended solids"	Output	Emission	Suspended solids	230			mg	Water	
Notes: "Mercaptans", <0.5 mg	Output	Emission	Thiols	0.25			mg	Air	
Notes: "VCM", <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Water	
Notes: "VCM", <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Air	
Notes: "Zn++", <0.5 mg	Output	Emission	Zn	0.25			mg	Water	
Notes: "Toluene"	Output	Product	Toluene	1			kg	Technosphere	
Notes: "Inert chemical"	Output	Residue	Inert chemical waste	790			mg	Technosphere	
Notes: "Mineral"	Output	Residue	Mineral waste	7.6			g	Technosphere	
Notes: Aggregation of different wastes: "Mixed industrial", 570 mg "Unspecified", 14 mg "Construction", 39 mg "Metals", 8 mg "Paper & board", <0.5 mg "Wood waste", <0.5 mg	Output	Residue	Mixed industrial waste	631			mg	Technosphere	
Notes: "Plastics"	Output	Residue	Plastics waste	1			mg	Technosphere	
Notes: "Regulated chemical"	Output	Residue	Regulated chemical waste	530			mg	Technosphere	
Notes: "Slags/ash"	Output	Residue	Slags and ash	1.5			g	Technosphere	
Notes: "To incinerator"	Output	Residue	Waste to incineration	480			mg	Technosphere	
Notes: "To recycling"	Output	Residue	Waste to recycling	42			mg	Technosphere	

About Inventory

Publication	"Eco-profiles of the European plastics industry", reports for toluene and naphtha. "Eco-profiles of plastics and related intermediates: Methodology", I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe)

	The APME project co-ordinator: Vince Matthews. The members of the original independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom. -- Editor: Data were entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 2001-01-19. Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 29 October 2001 ---
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as building blocks for use in the construction of complete life cycle analyses. 1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies. - Internal company benchmarking. - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occurred since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for toluene production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data on the toluene production processes have been supplied by 10 plants in 4 European countries. Data are probably fairly representative for production of toluene in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Note that emissions <0.5 mg (0.25 mg in data table) may be far below 0.5 mg in some cases. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, data for each production sequence (i.e.

	each plant + its specific suppliers) are calculated separately. The final result is the average of the results from the individual production sequences weighted by the output from each sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO_2 emission. CO_2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO_2 emission (kg/MJ fuel) = 3.67 x {mass fraction of carbon in fuel}/{calorific value of fuel}. The following interpretations/changes from the original report have been made by Gunnar Mattson, ABB Corporate Research: - Nuclear energy has been recalculated to natural uranium resource. - Ferromanganese, Phosphate and Rutile have been recalculated to the corresponding amounts of Mn, P and Ti resources. - The energy resources Hydrogen and Sulphur have been excluded, as these parameters do not represent true natural resources. - Emissions and resources <0.5 mg (<1 mg in the Eco-profiles result tables) are presented as 0.25 mg, i.e. 1/2 of the ''<'' value. This is in accordance with common statistical procedure.
Notes	--- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 29 October 2001 <<< Changes made by Gunnar Mattson, ABB Corporate Research The general documentation of the data have been supplemented, to improve the transparency and the consistency with other published data sets from the APME reports.

SPINE LCI dataset: Extraction to xylene APME

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Extraction to xylene APME
Functional Unit	1 kg of xylenes (mixed)
Functional Unit Explanation	Xylene, dimethylbenzene, C6H5(CH3)2, is obtained as a mixture of three isomers, o-xylene, m-xylene and p-xylene, all of which are liquid at room temperature. The mixture is used as an organic solvent; p-xylene is used as a raw material in the production of PET; o-xylene is used in the synthesis of phthalic anhydride.
Process Type	Cradle to gate
Site	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	Production of xylene including all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. Most xylene is produced directly from naphtha by catalytic reforming, a process in which naphthenic compounds in naphtha are dehydrogenated. The basic feedstock is thus converted into a mixture of products, mainly benzene, toluene and xylene; hence, the process is often called the BTX process. Benzene and the other aromatics are isolated in the pure state from the output of the reformer by solvent extraction and fractional distillation. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and delivery; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been traced back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 8 plants in 4 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. Some more information about the processes are found in the ''Eco-profiles...'' reports for xylenes (mixed) and naphtha, and the Methodology report, which are available at APME''s web site http://lca.apme.org.

System Boundaries	
Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available.'' Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under their specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment. Emissions <0.5 mg were presented as <1 mg in the Eco-profiles result tables. In this

	activity, however, they are presented as 0.25 mg (1/2 of the maximum value 0.5 mg). Note that the actual values may be far below 0.5 mg in some cases. The energy resources Hydrogen and Sulphur have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table.
Time Boundary	Data refer to the years 1990-96. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data for xylene production plants that produced 720000 tonnes. Data were supplied by 8 plants in 4 countries: Belgium, Germany, Italy and Netherlands. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For the intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides that plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included.) - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most other cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0.01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Methodology report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g., sulphuric acid is used as a drying agent for chlorine; therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity.
Systems Expansions	Not applied. The amount of Recovered energy is reported as a negative primary energy equivalent input.

Flow Data

General Activity QMetaData

Date Conceived	1990 to 1996
Data Type	Derived, mixed
Represents	

Method	European average data. Results are based on data supplied by 8 xylene production plants in 4 countries: Belgium, Germany, Italy and Netherlands. Their total production was 720000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. Emissions and resources <0.5 mg have been assumed by Gunnar Mattson ABB Corporate Research (GM) to be 0.25 mg, i.e. half the ''<'' values given, which is in accordance with common statistical procedure. The energy resources Hydrogen (0.04 MJ) and Sulphur (<0.01 MJ) have been excluded by GM, since these parameters do not represent true natural resources, but are reported as primary energy equivalents for energy balancing purposes. Probably they are included in other resources, e.g. crude oil and gas. Nuclear energy has been recalculated to natural uranium resource. Only Hydro energy and Unspecified energy are kept as primary energy equivalents in the flow table. 2001-05-31 SECRC/GM
Literature Reference	''Eco-profiles of the European plastics industry'', reports for xylenes (mixed) and naphtha. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe)
Notes	In the result tables in the ''Eco-profiles...'' report, not only total fuels and feedstocks, emissions to air and water, and solid waste are presented, but also the amounts caused by fuel production, fuel use, transport, feedstock (only for fuels and feedstocks) and processes. As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field. Please note: Some other interpretations/changes have been made from the original report by Gunnar Mattson, ABB Corporate Research. See Method and AboutData for details.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: ''air'', compressed air	Input	Natural resource	Air	39			g	Ground	
Notes: ''barytes'', <0.5 mg	Input	Natural resource	Barytes	0.25			mg	Ground	
Notes: ''bauxite''	Input	Natural resource	Bauxite	400			mg	Ground	
Notes: ''bentonite''	Input	Natural resource	Bentonite	200			mg	Ground	
Notes: ''Biomass''	Input	Natural resource	Biomass	110			mg	Ground	
Notes: ''calcium sulphate''	Input	Natural resource	CaSO4	20			mg	Ground	
Notes: ''chalk'', <0.5 mg	Input	Natural resource	Chalk	0.25			mg	Ground	
Notes: ''chromium'', <0.5 mg	Input	Natural resource	Chromium in ore	0.25			mg	Ground	
Notes: ''clay''	Input	Natural resource	Clay	9			mg	Ground	
Notes: ''Crude oil'', gross primary fuel and/or feedstock resource, 560 g or 25.1 MJ.	Input	Natural resource	Crude oil	560			g	Ground	
Notes: ''dolomite''	Input	Natural resource	Dolomite	8			mg	Ground	
Notes: ''feldspar'', <0.5 mg	Input	Natural resource	Feldspar	0.25			mg	Ground	
Notes: ''fluorspar'', <0.5 mg	Input	Natural resource	Fluorspar	0.25			mg	Ground	
Notes: ''granite'', <0.5 mg	Input	Natural resource	Granite	0.25			mg	Ground	
Notes: ''gravel''	Input	Natural resource	Gravel	2			mg	Ground	
Notes: ''Coal'', gross primary fuel and/or feedstock resource, 17 g or 0.47 MJ. 270 mg ''Metallurgical coal'' is included.	Input	Natural resource	Hard coal	17			g	Ground	

Notes: ''Hydro'', gross primary energy equivalent (80% electricity production efficiency has been assumed in APME reports).	Input	Natural resource	Hydro energy	0.02			MJ	Ground	
Notes: ''iron''	Input	Natural resource	Iron in ore	710			mg	Ground	
Notes: ''potassium chloride'', <0.5 mg	Input	Natural resource	KCl	0.25			mg	Ground	
Notes: ''lead'', <0.5 mg	Input	Natural resource	Lead in ore	0.25			mg	Ground	
Notes: ''Lignite'', gross primary fuel and/or feedstock resource, 1.5 g or 0.02 MJ.	Input	Natural resource	Lignite	1.5			g	Ground	
Notes: ''limestone''	Input	Natural resource	Limestone	5.6			g	Ground	
Method: ''ferromanganese'', 1 mg. It was assumed by SECRC/GM that the ferromanganese contained 80% Mn. Notes: ''ferromanganese''	Input	Natural resource	Manganese in ore	0.8			mg	Ground	
Notes: ''nitrogen''	Input	Natural resource	N2	13			g	Ground	
Notes: ''sodium chloride''	Input	Natural resource	NaCl	920			mg	Ground	
Notes: ''Gas/condensate'' (natural gas), gross primary fuel and/or feedstock resource, 870 g or 43.5 MJ.	Input	Natural resource	Natural gas	870			g	Ground	
Notes: ''nickel'', <0.5 mg	Input	Natural resource	Nickel in ore	0.25			mg	Ground	
Notes: ''oxygen''	Input	Natural resource	O2	21			mg	Ground	
Notes: ''olivine''	Input	Natural resource	Olivine	6			mg	Ground	
Notes: ''Peat''	Input	Natural resource	Peat	1			mg	Ground	
Method: ''phosphate as P2O5'', <0.5 mg, which corresponds to <0.22 mg P (44% P in P2O5). Notes: ''phosphate as P2O5''	Input	Natural resource	Phosphorus in ore	0.11			mg	Ground	
Notes: ''sand''	Input	Natural resource	Sand	72			mg	Ground	
Notes: ''shale''	Input	Natural resource	Shale	58			mg	Ground	
Notes: ''sulphur (bonded)'', 4 mg + ''sulphur (elemental)'', 9 mg	Input	Natural resource	Sulphur in ore	13			mg	Ground	
Method: ''rutile'', <0.5 mg, which should correspond to <0.3 mg Ti, assuming that the rutile (TiO2) mineral contained 60% Ti. Notes: ''rutile''	Input	Natural resource	Titanium in ore	0.15			mg	Ground	
Notes: ''Unspecified'', gross primary fuel and/or feedstock, <0.005 MJ	Input	Natural resource	Unspecified energy	0.0025			MJ	Ground	
Data type: Derived, mixed Method: ''Nuclear'' energy, 0.20 MJ, gross primary energy equivalent (35% electricity production efficiency has been assumed in APME reports). 35% efficiency [1] and 7.85 mg uranium resource/MJ electricity [2] are assumed by GM, i.e. 0.20 MJ Nuclear energy should correspond to 0.20*0.35*7.85=0.55 mg of natural uranium (U) resource. 2001-05-31 SECRC/GM Literature: [1] ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. [2] ''Oekoinventare von Energiesystemen'', R. Frischknecht & al, ETH, 1996. Notes: ''Nuclear''	Input	Natural resource	Uranium in ore	0.55			mg	Ground	
Notes: ''Gross water resources'', total. Aggregation of different sources: ''Public supply'', 3.1 kg ''River/canal'', 42 g ''Sea'', 96 kg ''Unspecified'', 200 g ''Well'', 700 mg 3.2 kg of the water is	Input	Natural resource	Water	99			kg	Ground	

used for processing, 96 kg for cooling.									
Notes: ''Wood''	Input	Natural resource	Wood	1			mg	Ground	
Notes: ''zinc'', <0.5 mg	Input	Natural resource	Zinc in ore	0.25			mg	Ground	
Notes: ''Recovered energy'', gross primary energy equivalent	Input	Refined resource	Recovered energy	-2.62			MJ	Technosphere	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Water	
Notes: ''DCE'', <0.5 mg	Output	Emission	1,2-Dichloroethane	0.25			mg	Air	
Notes: ''Acid (H+)''	Output	Emission	Acid as H+	35			mg	Water	
Notes: ''Al+++'', <0.5 mg	Output	Emission	Al	0.25			mg	Water	
Notes: ''Aldehydes (CHO)'', unspecified, <0.5 mg	Output	Emission	Aldehydes	0.25			mg	Air	
Notes: ''Aromatic-HC'', unspecified	Output	Emission	Aromatics	44			mg	Air	
Notes: ''Arsenic'', <0.5 mg	Output	Emission	As	0.25			mg	Water	
Notes: ''BOD'', biochemical oxygen demand	Output	Emission	BOD	3			mg	Water	
Notes: ''Ca++'', <0.5 mg	Output	Emission	Ca	0.25			mg	Water	
Notes: ''CFC/HCFC'', unspecified	Output	Emission	CFCs/HCFCs	1			mg	Air	
Notes: ''Organo-Cl'', unspecified, <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Air	
Notes: ''Organo-chlorine'', <0.5 mg	Output	Emission	Chloroorganics	0.25			mg	Water	
Notes: ''Cl-''	Output	Emission	Cl-	300			mg	Water	
Notes: ''Dissolved Cl2'', <0.5 mg	Output	Emission	Cl2	0.25			mg	Water	
Notes: ''Cl2'', <0.5 mg	Output	Emission	Cl2	0.25			mg	Air	
Notes: ''CN-'', <0.5 mg	Output	Emission	CN-	0.25			mg	Water	
Notes: ''CO''	Output	Emission	CO	830			mg	Air	
Method: CO2, unlike other emissions, is not measured but calculated from the amounts of combusted fuels. The amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes. CO2 emission from use of biomass has been subtracted from the total. Notes: ''CO2''	Output	Emission	CO2	1.3			kg	Air	
Notes: ''CO3--''	Output	Emission	CO32-	170			mg	Water	
Notes: ''COD'', chemical oxygen demand	Output	Emission	COD	270			mg	Water	
Notes: ''CrO3'', <0.5 mg, which corresponds to <0.26 mg Cr(VI), as there is 52% Cr in CrO3.	Output	Emission	Cr(VI)	0.13			mg	Water	
Notes: ''CS2'', <0.5 mg	Output	Emission	CS2	0.25			mg	Air	
Notes: ''Cu+/Cu++'', <0.5 mg	Output	Emission	Cu	0.25			mg	Water	
Notes: ''Dissolved organics'', unspecified	Output	Emission	Dissolved organics	20			mg	Water	
Notes: ''Dissolved solids'', unspecified	Output	Emission	Dissolved solids	55			mg	Water	
Notes: ''F-'', <0.5 mg	Output	Emission	F-	0.25			mg	Water	
Notes: ''F2'', <0.5 mg	Output	Emission	F2	0.25			mg	Air	
Notes: ''Fe++/Fe+++'', <0.5 mg	Output	Emission	Fe	0.25			mg	Water	
Notes: ''Hydrogen (H2)''	Output	Emission	H2	37			mg	Air	
Notes: ''H2S'', <0.5 mg	Output	Emission	H2S	0.25			mg	Air	
Notes: ''H2SO4'', <0.5 mg	Output	Emission	H2SO4	0.25			mg	Air	
Notes: ''HCl''	Output	Emission	HCl	9			mg	Air	
Notes: ''HCN'', <0.5 mg	Output	Emission	HCN	0.25			mg	Air	
Notes: ''HF'', <0.5 mg	Output	Emission	HF	0.25			mg	Air	
Notes: ''Mercury (Hg)'', <0.5 mg	Output	Emission	Hg	0.25			mg	Air	
Notes: ''Hg'', <0.5 mg	Output	Emission	Hg	0.25			mg	Water	
Notes: ''Hydrocarbons'', unspecified	Output	Emission	Hydrocarbons	2.6			g	Air	
Notes: ''Hydrocarbons'', unspecified	Output	Emission	Hydrocarbons	39			mg	Water	
Notes: ''K+'', <0.5 mg	Output	Emission	K	0.25			mg	Water	
Notes: ''Metals'', unspecified	Output	Emission	Metals	1			mg	Air	
Notes: ''Metals - unspecified''	Output	Emission	Metals	550			mg	Water	
Notes: ''Methane''	Output	Emission	Methane	4			g	Air	
Notes: ''Mg++'', <0.5 mg	Output	Emission	Mg	0.25			mg	Water	
Notes: ''Other nitrogen''	Output	Emission	N total	7			mg	Water	

Notes: "N2O", <0.5 mg	Output	Emission	N2O	0.25			mg	Air	
Notes: "Na+"	Output	Emission	Na	27			mg	Water	
Notes: "Ammonia (NH3)", <0.5 mg	Output	Emission	NH3	0.25			mg	Air	
Notes: "NH4"	Output	Emission	NH4+	2			mg	Water	
Notes: "Ni++", <0.5 mg	Output	Emission	Ni	0.25			mg	Water	
Notes: "NO3-"	Output	Emission	NO3-	2			mg	Water	
Notes: "NOx"	Output	Emission	NOx	4.8			g	Air	
Notes: "Detergent/oil", unspecified	Output	Emission	Oil	32			mg	Water	
Notes: "Other organics", <0.5 mg	Output	Emission	Organics	0.25			mg	Water	
Notes: "Other organics", unspecified, <0.5 mg	Output	Emission	Organics	0.25			mg	Air	
Notes: "Polycyclic-HC", <0.5 mg	Output	Emission	PAH	0.25			mg	Air	
Notes: "Dust"	Output	Emission	Particles	540			mg	Air	
Notes: "Pb", <0.5 mg	Output	Emission	Pb	0.25			mg	Water	
Notes: "Lead (Pb)", <0.5 mg	Output	Emission	Pb	0.25			mg	Air	
Notes: "Phenol"	Output	Emission	Phenol	2			mg	Water	
Notes: "Phosphate as P2O5", 1 mg, which corresponds to 1.3 mg PO43- (1 g P2O5 corresponds to 1.34 g PO43-).	Output	Emission	PO43-	1.3			mg	Water	
Notes: "Sulphur/sulphide", <0.5 mg	Output	Emission	S2-	0.25			mg	Water	
Notes: "SOx", i.e. SO2 + SO3	Output	Emission	SO2	3.5			g	Air	
Notes: "SO4--"	Output	Emission	SO42-	190			mg	Water	
Notes: "Suspended solids"	Output	Emission	Suspended solids	180			mg	Water	
Notes: "Mercaptans", <0.5 mg	Output	Emission	Thiols	0.25			mg	Air	
Notes: "VCM", <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Water	
Notes: "VCM", <0.5 mg	Output	Emission	Vinyl chloride	0.25			mg	Air	
Notes: "Zn++", <0.5 mg	Output	Emission	Zn	0.25			mg	Water	
Notes: "Xylenes (mixed)"	Output	Product	Xylene	1			kg	Technosphere	
Notes: "Inert chemical"	Output	Residue	Inert chemical waste	850			mg	Technosphere	
Notes: "Mineral"	Output	Residue	Mineral waste	5.2			g	Technosphere	
Notes: Aggregation of different wastes: "Mixed industrial", 400 mg "Unspecified", 5 mg "Construction", 29 mg "Metals", 4 mg "Paper & board", <0.5 mg "Wood waste", <0.5 mg	Output	Residue	Mixed industrial waste	440			mg	Technosphere	
Notes: "Plastics", <0.5 mg	Output	Residue	Plastics waste	0.25			mg	Technosphere	
Notes: "Regulated chemical"	Output	Residue	Regulated chemical waste	360			mg	Technosphere	
Notes: "Slags/ash"	Output	Residue	Slags and ash	1.1			g	Technosphere	
Notes: "To incinerator"	Output	Residue	Waste to incineration	450			mg	Technosphere	
Notes: "To recycling", <0.5 mg	Output	Residue	Waste to recycling	0.25			mg	Technosphere	

About Inventory

Publication	"Eco-profiles of the European plastics industry", reports for xylenes (mixed) and naphtha. "Eco-profiles of plastics and related intermediates: Methodology", I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. (APME = Association of Plastics Manufacturers in Europe) The APME project co-ordinator: Vince Matthews. The members of the original independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom. --- Editor: Data were entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 2001-05-31. Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 29 October 2001 ---
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.

Detailed Purpose	Eco-profiles are intended primarily as building blocks for use in the construction of complete life cycle analyses. 1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies. - Internal company benchmarking. - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occurred since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for xylene production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data on the xylene production processes have been supplied by 8 plants in 4 European countries. Data are probably fairly representative for production of xylene in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Note that emissions <0.5 mg (0.25 mg in data table) may be far below 0.5 mg in some cases. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, data for each production sequence (i.e. each plant + its specific suppliers) are calculated separately. The final result is the average of the results from the individual production sequences weighted by the output from each sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45.0 MJ/kg for crude oil, 38.8 MJ/m3 (54.1 MJ/kg) for natural gas, 28.0 MJ/kg for coal, 15.0 MJ/kg for lignite, 9.3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission (kg/MJ fuel) = 3.67 x

	{mass fraction of carbon in fuel}/{calorific value of fuel}. The following interpretations/changes from the original report have been made by Gunnar Mattson, ABB Corporate Research: - Nuclear energy has been recalculated to natural uranium resource. - Ferromanganese, Phosphate and Rutile have been recalculated to the corresponding amounts of Mn, P and Ti resources. - The energy resources Hydrogen and Sulphur have been excluded, as these parameters do not represent true natural resources. - Emissions and resources <0.5 mg (<1 mg in the Eco-profiles result tables) are presented as 0.25 mg, i.e. 1/2 of the ''<'' value. This is in accordance with common statistical procedure.
Notes	

SPINE LCI dataset: Extraction, beneficiation and grinding of kieserite

Administrative	
Finished	Y
Date Completed	99-01-25
Copyright	
Availability	Public

Technical System	
Name	Extraction, beneficiation and grinding of kieserite
Functional Unit	1 kg of ground kieserite ($MgSO_4*H_2O$).
Functional Unit Explanation	
Process Type	Other
Site	
Sector	Metal and mineral mining
Owner	
Technical system description	This dataset is intended to represent average data for production of kieserite used in production of fertilisers used in Sweden. Data have been given by Kali & Salz in Germany, no specific site has been studied. It is uncertain what techniques for extraction, beneficiation and grinding the data given by Kali & Salz represent. Kieserite is mined simultaneously with potash salt. The text below only gives generic information about extraction and beneficiation of potash salt, the data do not necessarily include these techniques. Information about different techniques of mining and beneficiation of potash salt: Salts deposits were formed by the evaporation of sea water, in which the most important ions are sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}), calcium (Ca^{2+}), chloride (Cl^-) and sulphate (SO_4^{2-}) (Ullmann, vol. A 22, 1993). Beds of potassium-bearing salts, potash salts, exist in different shapes and at varying depths and the largest deposits are found in the United States, in Canada, in the former Soviet Union, in France and in Germany (Encyclopedia of Chemical Processing and Design, vol. 41, 1992, Patyk, 1996). The most important potash mineral is sylvinite, a mixture of sylvite (KCl) and halite or rock salt (NaCl) and so called hard salts, i.e. sylvite (KCl) and kieserite ($MgSO_4*H_2O$) (Phosphorus & Potassium, 1983; Patyk, 1996). Potash minerals are water-soluble and are therefore not found as an outcropping because of the effects of the weather and consequently surface indications of potash are rare or non-existent. Underground deposits have usually been discovered during oil exploration, since both oil and potash salt are sedimentary-type deposits and petroleum companies have been in a better financial position to conduct exploration than potash companies (Encyclopaedia of Chemical Processing and Design, vol. 41, 1992). About 95 % of the potassium salts is destined for the fertiliser industry and potassium chloride is the most important potassium compound in fertilisers (Phosphorus & Potassium, 1983, Patyk, 1996). Extraction of Potash Salt Shaft Mining Since mineral salts are very soluble any flow of water from the overlying strata, which

normally are water bearing, must be prevented. When sinking a shaft, this causes difficulties. A technique that involves freezing is currently used to avoid influx of water when sinking a mineshaft. The shaft itself is then protected from the water bearing rocks by the use of segments, made of cast iron or steel-reinforced concrete, bolted together to form rings. The shafts generally have a diameter of 5 -7 meters and the depth can be more than 1000 meters (Ullmann, vol. A 22, 1993).

The mining methods of potash ore depend on its purity and the shape of the deposits, the seams. In horizontal deposits the most common method of extraction is by cutting with heavy machinery and rooms are generally created by removing the salt and pillars are left to support the cover rocks and prevent them from collapsing. Another method of mining in horizontal deposits is longwall mining which is a caving operation (Ullmann, vol. A 22, 1993). Then machines with integral shearers are used, which can work at two different levels concurrently, with the upper face being mined some 25-30 meters ahead of the lower face. Mining faces are supported by self-advancing support systems with prop-chocks installed every 3-5 meters behind the shearer. The latter method was developed to increase the mine output since the room and pillar method left too much of the mineral unreclaimed (Phosphorus & Potassium, 1983).

In steeply dipping deposits the underhand stooping mining systems is the most favoured method. This involves the mining taking place simultaneously at different levels in the salt dome and the spiral roadways connecting the main levels. Often funnelling of ore is practised which implies that ore is dropped by a series of shafts to the lower level and then transported to the foot of the main shaft for removal. This way of transporting the ore is used to minimise the haulage (Phosphorus & Potassium, 1983).

The recovered material is transported by trackless diesel or cable-fed electric loaders. Sometimes conveyor belts and electric or diesel trains are used for transportation along underground roads. Since the introduction of diesel-powered machinery and vehicles, extra attention must be given to ventilation and therefore powerful fans are necessary. Finally, the ore is hoisted in the shaft in the large skips (Ullmann, vol. A 22, 1993).

Solution Mining

Solution mining is an alternative method of mining for potash ore, which makes it possible to exploit reserves where conventional mining is impossible, e.g. at great depth. This method eliminates high expense of sinking a shaft and can also be used where existing mine works are available but conventional mining methods are no longer feasible, even though extensive reserves still exist (Ullmann, vol. A 22, 1993). A reason why conventional mining is not possible anymore can be flooding in the mine, too much folding encountered or high occurrence of methane gas in the deposit (Encyclopedia of Chemical Processes and Design, vol. 41, 1992). The principles of the solution mining process are that water or an unsaturated solution of potassium chloride is passed through a system of boreholes into the potash seam. Potassium chloride and sodium chloride are dissolved and the almost saturated solution is then pumped up to the surface and fed to the production plant. The process is based on a series of patents and details have not yet been published (Ullmann, vol. A 22, 1993).

Extraction Methods Used in Different Countries

In Germany the potash production is five times the amount sold in the country (Patyk, 1996). The geological conditions vary widely between the northern and the southern regions and, consequently different mining methods are employed to extract the ore. The southern deposits, between the Fulda and Werra rivers, are at easily-accessible levels, but the seams are relatively thin; 1.3 -3.5 m. The potassium content is in the range 7 – 15 % K_2O. The ore is extracted by conventional mining and the room and pillar method is used in most cases. In the northern Hannover region the potash beds are steeply dipping and folded and the deposits have sometimes the shape of a dome (Ullmann, vol. A 22, 1993). Therefore they are less accessible, but the seam thickness vary between 4 and 30 meters and the K_2O content is between 13-14 %, on average 3,5 % higher than the southern deposits. The geological conditions in this region favour the underhand stooping mining system (Phosphorus & Potassium, 1983).

In France beds of potassium-bearing salts extend under the Plain of Alsace. Two sylvinite beds are found in three different basins. The upper bed has a K_2O content of 20-27 % and a thickness of about 1.5 meters, while the lower bed which contains 12-20 % K_2O is thicker, at about one to five meters. The room and pillar method has been practised for a long time, but in order to increase the mine output longwall is now predominantly used (Fertilizer Manual, 1998).

In the former Soviet Union the potash production is centred around three main regions; the Urals, Belarus and Ukraine (Fertilizer Manual, 1998). The room and pillar method has been extensively used, but nowadays longwall mining is the most frequent system of extraction (Encyclopedia of Chemical Processing and Design, vol. 41, 1992; Ullmann, vol. A 22, 1993).

The room and pillar method has been widely used for mining of potash ore in the United States. However, some mines has been converted to solution mining, e.g. a mine in Utah where conventional mining operations had to be terminated due to severe technological and geological problems (Encyclopedia of Chemical Processing and Design, vol. 41, 1992; Ullmann, vol. A 22, 1993).

In Canada solution mining and the room and pillar method are practised. Mining in Saskatchewan, Canada is relatively clean and straightforward since the evaporite beds are regular, tabular and relatively untilted (Encyclopedia of Chemical Processing and Design, vol. 41, 1992).

Beneficiation of Potash Ore
In order to increase the concentration of potassium chloride to 95 % three different beneficiation techniques are mainly applied in the potash industry; flotation, thermal dissolution-crystallisation or hot leaching and electrostatic separation (Patyk, 1996).

The salt minerals in potash ores are intergrown with other salt minerals to varying extents. The most important minerals are sylvinite, sylvite mixed with halite, and so-called hard salts, sylvite and kieserite (Patyk, 1996). Therefore the ore must be sufficiently reduced in size, so that individual components are accessible, before the minerals can be separated and the useful components recovered. Potash salts are relatively easily size-reduced by grinding. In the hot leaching process potassium chloride is extracted and must therefore not be occluded inside other minerals, which implies an upper grain size limit of 4-5 mm. For the mechanical processes, i.e. flotation and electrostatic separation, liberation of the minerals must be complete, which means that individual grains must consist as much as possible of pure minerals. For German sylvinite ores and hard salts, this is achieved by grinding to a maximum grain size of 0.8-1.0 mm, but for coarser sylvinite ores of, for example, Saskatchewan, Canada a size reduction to < 9 mm would give an adequate liberation (Ullmann, vol. A 22, 1993).

Flotation
Flotation essentially relies on the fact that fresh mineral surfaces can be induced to adopt either a hydrophobic or hydrophilic attitude in the solution by conditioning with specific surface chemicals. Air bubbles are then introduced into the solution and the mineral particles will, if they are hydrophobic, attach themselves to air bubbles at the air/water interface and float up to the top where they can be mechanically removed (Fertilizer Manual, 1998). Common collectors are hydrochloride and acetate salts of aliphatic amides with a carbon chain length of 12-24. Frothers are often added before the slurry enters the flotation cell (Encyclopedia of chemical Processes and Design, vol. 41, 1992). The flotation process has advantages over other processes, in particular the crystallisation process, in that total energy consumption is generally lower and maintenance and equipment depreciation charges generally less than for other comparable processes (Fertiliser Manual, 1998).

Dissolution-Crystallisation or Hot Leaching
The basis of the dissolution-crystallisation method of benificiation, even called the hot leaching process, lies in the fact that potassium chloride is very much more soluble in hot water than in cold, whereas sodium chloride is only slightly more soluble at 100°C than at 20°C. In solutions saturated with respect to both sodium and potassium chloride, sodium chloride is actually less soluble at higher temperatures. Firstly, the sylvinite ore is crushed and washed with cool, saturated sodium/potassium chloride solution. Clay is removed and the clarified solution is then heated and used to dissolve the potassium chloride in the washed ore. Any undissolved sodium chloride is discarded as tailings. Finally, the solution is cooled under vacuum, which results in the crystallisation of potassium chloride and the crystals are separated, washed and dried (Fertilizer Manual, 1998). The remaining brine, mostly sodium chloride, is recirculated and heat exchangers recover valuable heat. A major cost in this process is the heating of the cool mother liquid from the crystalliser before recycling it to the dissolution stage (Phosphorus & Potassium, 1983). However, this method was used before the introduction of flotation in the mid-1930s and it is to prefer when the ores are excessively high in either clay or carnallite (Encyclopedia of Chemical Processes and Design, vol. 41, 1992).

Electrostatic Separation
Electrostatic separation is a dry technique in which a mixture of minerals may be differentiated according to their electrical conductivity. For potash minerals, which are not naturally conductive, the separation must be preceded by a conditioning step that induces the minerals to carry electrostatic charges of different magnitude and, if possible, different polarities. In Germany, the researchers have developed a process for dry beneficiation of complex potash ores. Particle size, conditioning agents, and relative humidity are used in the electrostatic separation zones to separate ore into three fractions (Fertiliser Manual, 1998). The components are separated in stages, using up to four stages and the particles pass direct from one stage to another. The company that has developed this process, Kali und Salz GmbH, is silent about the process, but a stage seems to be two rows of tubes, 25 cm apart and 2.5 m long, at 100 kV direct current. Using this process for beneficiation, all the energy that is consumed when drying out the potash beneficiated by wet means is saved and tailings disposal problems associated with alternative wet separation processes eliminated (Encyclopedia of Chemical Processes and Design, vol. 41, 1992).

Methods of Beneficiation used in Different Countries
In Germany the hot leaching process is the dominating method of beneficiation of potash ores (Ullmann, vol. A 22, 1993). Electrostatic separation is also used to a large extent (Fertilizer Manual, 1998).

Flotation is used at one plant in France and the hot leaching process is practised at the two remaining ones (Fertilizer Manual, 1998; Encyclopedia of Chemical Processes and Design, vol. 41, 1992).

In Spain and in the United Kingdom flotation is used exclusively for the separation of potassium chloride from sodium chloride (Encyclopedia of Chemical Processes and Design, vol. 41, 1992).

In the former Soviet Union the hot leaching process is still a widely used method for beneficiation of potash ores, especially in old plants. Generally the flotation process is used in new installations, except when potash ores contain high levels of clay or when magnesium chloride levels exceed 30 % (Phosphorus & Potassium, 1983).

In Canada and in the United States flotation is predominantly used as the main product process, except for the two solution mines (Encyclopedia of Chemical Processes and Design, vol. 41, 1992). In some plants, especially in Canada small hot leaching plants are also operated, in which product fines are recrystallised or potassium chloride is extracted and crystallised from the flotation residues and clay slurries (Ullmann, vol. A 22, 1993).

Potassium chloride and potassium sulphate are also produced from brines on commercial basis from six sources in the world, including two lakes, the Great Salt Lake in Utah and the Dead Sea between Israel and Jordan; two subsurface brine sources, one in California and one in Utah; two solution mines, one in Utah and one in Saskatchewan, Canada. Potassium sulphate is produced from the Great Salt Lake and the subsurface brine in California and potassium chloride is produced from all brines except the one from Great Salt Lake. Brines from the sources in Saskatchewan and in California are concentrated in multiple-effect evaporators and crystals of the final product are grown in multiple-stage vacuum crystallisers. The brine from the other sources is concentrated by solar evaporation (Encyclopedia of Chemical Processes and Design, vol. 41, 1992).

Environmental Aspects
In addition to the consumption of energy, the main environmental problem of the potash industry is disposal of process waste (Ullmann, vol. A 22, 1993). When processing potash ore to saleable product three types of waste products are generated; liquid and solid salt tailings, insolubles or slimes and dust. Salt tailings are generally the major environmental concern and the composition of the waste depends on the type of ore treated. Waste from sylvinite processing consists mainly of halite, waste from treatment of hard salts are halite and kieserite and from treatment of carnallitic ore are halite and carnallite (Phosphorus & Potassium, 1983; Ullmann, vol. A 22, 1993). Concentrated salt is a toxic waste which does not decay and requires dilution in order to be non-toxic (Phosphorus & Potassium, 1983).

There are four methods for disposing of waste; stacking, backfilling, pumping into the ground and discharge into natural water systems (Ullmann, vol. A 22, 1993). Until recently, plants merely stacked their waste salts and slimes and injected the excess brine underground, or dumped both into the nearest river. New plants have been required to eliminate these practices (Fertlizer Manual, 1998). In case of stacking, measures must be taken so that salt solutions that run off the deposited material, such as solid salt tailings and insolubles, not harm the environment when they are absorbed into the ground. If the ground underneath the stack is not impermeable, layers of clay or plastic sheets must seal it. In Germany, the solid waste is formed into steep conical heaps in order to decrease the amount of run off water formed by rainfall and to minimise the required ground area. If mining methods are suitable and certain geological requirements are met solid waste can be backfilled in the mines. This is the main method of waste disposal in the potash works in the northern Germany, where the salt beds are steeply inclined and this method is also practised in some mines in Canada. However, backfilling is not possible for technical and economic reasons in most potash works (Ullmann, vol. A 22, 1993).

Under certain geological conditions it is possible to pump salt solutions back into the ground. For this purpose the formation used must possess sufficient porosity and permeability and must have no contact with water bearing formations. For example, in the Werra potash region of Germany large quantities of brines have been pumped into a porous dolomite layer. However, in this region the amount of brines produced has decreased drastically since the introduction of electrostatic separation of potash ore. This beneficiation process was developed in the aim of reducing the amount of liquid salt tailings (Ullmann, vol. A 22, 1993). Sea disposal is practised in the United Kingdom (Fertilizer Manual, 1998) and by one of the works in Canada and presents few major problems if the outlet is sufficiently far away from the coast. The potash works on the Dead Sea can dispose waste brine in the Dead Sea itself, without problems since the waste brine is more diluted than the water in the Dead Sea. For most potash works, waste brines must be disposed into natural flowing water since neither underground disposal nor disposal in seawater is possible. This is strictly regulated in most countries, but although, for example, the salt halt in the Werra River, Germany is very high due to the potash works in the eastern part of the Werra region (Ullmann, vol. A 22, 1993).

The only important atmospheric pollution caused by the production of potassium salts is dust emitted from the drying plant and from the handling of the ore and the products (Ullmann, vol. A 22, 1993). Such emissions contain primarily a mixture of potassium chloride and sodium chloride and deposition of the dust may be beneficial or hazardous to soil productivity depending on the level of emissions (Phosphorus & Potassium, 1983).

References:
Encyclopedia of Chemical Processing and Design (1992). Volume 41. p. 155-158.

Fertilizer manual (1998). United Nations Industrial Development Organization (UNIDO) and International Fertilizer Development Center (IFDC). Published by Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

Patyk A (1996). International Conference on Application of Life Cycle Assessment in Agriculture, Food and Non-Food Agro Industry and Forestry: Achievements and Prospects. IFEU-Institut für Energie- und Umweltforschung Heidelberg; Wilkensstrasse 3, D-69120 Heidelberg, Germany.

Phosphorus & Potassium (1983). No 128 November-December 1983.

Ullmann’s Encyclopedia of Industrial Chemistry (1993). Volume A 22. p. 47-80.

System Boundaries	
Nature Boundary	The system starts with extraction and ends with ground kieserite leaving the beneficiation site. Energy consumption for extraction and emissions from combustion of natural gas are not included.
Time Boundary	The data were given by Kali & Salz in 1998.
Geographical Boundary	The extraction, beneficiation and grinding takes place in Germany.
Other Boundaries	Energy consumption for extraction and emissions from combustion of natural gas are not included.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	Derived, unspecified
Represents	
Method	Information was taken from personal communication with Mr Aselmeyer at Kali & Salz in Germany.
Literature Reference	Personal communication: Aselmeyer F-B (1998). Kali und Salz GmbH, Kassel, Germany. tel: +49-561-301-2224.
Notes	In the result tables in the ''Eco-profiles...'' report, not only total fuels and feedstocks, emissions to air and water, and solid waste are presented, but also the amounts caused by fuel production, fuel use, transport, feedstock (only for fuels and feedstocks) and processes. As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field. Please note: Some other interpretations/changes have been made from the original report by Gunnar Mattson, ABB Corporate Research. See Method and AboutData for details.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Potash salt				kg	Ground	Germany
Notes: The energy input given by Kali & Salz is stated as being mostly natural gas.	Input	Refined resource	Natural gas	1.1			MJ	Technosphere	Germany
Notes: Kieserite (MgSO4*H2O).	Output	Product	Kieserite	1			kg	Technosphere	Germany

About Inventory	
Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The dataset is intended to be
General Purpose	To generate an inventory of emissions and use of resources due to the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare production of different fertilisers with each other but to generate a thorough inventory of emissions and use of resources due to the production of fertilisers used in Sweden. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems. Production of kieserite is one step in the line of production of some of the fertilisers containing potassium produced in Sweden.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-

Applicability	The dataset is applicable for extraction, beneficiation and grinding of kieserite in Germany. It is included in aggregated datasets for production of fertilisers at Hydro Agri AB in Köping, Sweden (cradle to gate).
About Data	The data are given by Kali und salz in Germany. No information on process emissions during extraction, beneficiation and grinding was given.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Extraction, beneficiation and grinding of potash salt

Administrative	
Finished	Y
Date Completed	99-01-25
Copyright	
Availability	Public

Technical System	
Name	Extraction, beneficiation and grinding of potash salt
Functional Unit	1 kg of ground potassium chloride (about 60 % K2O)
Functional Unit Explanation	
Process Type	Other
Site	
Sector	Metal and mineral mining
Owner	
Technical system description	This dataset is intended to represent average data for production of potash salt used in production of fertilisers used in Sweden. Data have been given by Kali & Salz in Germany, no specific site has been studied. It is uncertain what techniques for extraction, beneficiation and grinding the data given by Kali & Salz represent. The text below only gives generic information about extraction and beneficiation of potash salt, the data do not necessarily include these techniques. Salts deposits were formed by the evaporation of sea water, in which the most important ions are sodium (Na+), potassium (K+), magnesium (Mg2+), calcium (Ca2+), chloride (Cl-) and sulphate (SO42-) (Ullmann, vol. A 22, 1993). Beds of potassium-bearing salts, potash salts, exist in different shapes and at varying depths and the largest deposits are found in the United States, in Canada, in the former Soviet Union, in France and in Germany (Encyclopedia of Chemical Processing and Design, vol. 41, 1992, Patyk, 1996). The most important potash mineral is sylvinite, a mixture of sylvite (KCl) and halite or rock salt (NaCl) and so called hard salts, i.e. sylvite (KCl) and kieserite (MgSO4*H2O) (Phosphorus & Potassium, 1983; Patyk, 1996). Potash minerals are water-soluble and are therefore not found as an outcropping because of the effects of the weather and consequently surface indications of potash are rare or non-existent. Underground deposits have usually been discovered during oil exploration, since both oil and potash salt are sedimentary-type deposits and petroleum companies have been in a better financial position to conduct exploration than potash companies (Encyclopaedia of Chemical Processing and Design, vol. 41, 1992). About 95 % of the potassium salts is destined for the fertiliser industry and potassium chloride is the most important potassium compound in fertilisers (Phosphorus & Potassium, 1983, Patyk, 1996). Extraction of Potash Salt Shaft Mining Since mineral salts are very soluble any flow of water from the overlying strata, which normally are water bearing, must be prevented. When sinking a shaft, this causes difficulties. A technique that involves freezing is currently used to avoid influx of water when sinking a mineshaft. The shaft itself is then protected from the water bearing rocks by the use of segments, made of cast iron or steel-reinforced concrete, bolted together to form rings. The shafts generally have a diameter of 5 -7 meters and the depth can be more than

1000 meters (Ullmann, vol. A 22, 1993).

The mining methods of potash ore depend on its purity and the shape of the deposits, the seams. In horizontal deposits the most common method of extraction is by cutting with heavy machinery and rooms are generally created by removing the salt and pillars are left to support the cover rocks and prevent them from collapsing. Another method of mining in horizontal deposits is longwall mining which is a caving operation (Ullmann, vol. A 22, 1993). Then machines with integral shearers are used, which can work at two different levels concurrently, with the upper face being mined some 25-30 meters ahead of the lower face. Mining faces are supported by self-advancing support systems with prop-chocks installed every 3-5 meters behind the shearer. The latter method was developed to increase the mine output since the room and pillar method left too much of the mineral unreclaimed (Phosphorus & Potassium, 1983).

In steeply dipping deposits the underhand stooping mining systems is the most favoured method. This involves the mining taking place simultaneously at different levels in the salt dome and the spiral roadways connecting the main levels. Often funnelling of ore is practised which implies that ore is dropped by a series of shafts to the lower level and then transported to the foot of the main shaft for removal. This way of transporting the ore is used to minimise the haulage (Phosphorus & Potassium, 1983).

The recovered material is transported by trackless diesel or cable-fed electric loaders. Sometimes conveyor belts and electric or diesel trains are used for transportation along underground roads. Since the introduction of diesel-powered machinery and vehicles, extra attention must be given to ventilation and therefore powerful fans are necessary. Finally, the ore is hoisted in the shaft in the large skips (Ullmann, vol. A 22, 1993).

Solution Mining

Solution mining is an alternative method of mining for potash ore, which makes it possible to exploit reserves where conventional mining is impossible, e.g. at great depth. This method eliminates high expense of sinking a shaft and can also be used where existing mine works are available but conventional mining methods are no longer feasible, even though extensive reserves still exist (Ullmann, vol. A 22, 1993). A reason why conventional mining is not possible anymore can be flooding in the mine, too much folding encountered or high occurrence of methane gas in the deposit (Encyclopedia of Chemical Processes and Design, vol. 41, 1992). The principles of the solution mining process are that water or an unsaturated solution of potassium chloride is passed through a system of boreholes into the potash seam. Potassium chloride and sodium chloride are dissolved and the almost saturated solution is then pumped up to the surface and fed to the production plant. The process is based on a series of patents and details have not yet been published (Ullmann, vol. A 22, 1993).

Extraction Methods Used in Different Countries

In Germany the potash production is five times the amount sold in the country (Patyk, 1996). The geological conditions vary widely between the northern and the southern regions and, consequently different mining methods are employed to extract the ore. The southern deposits, between the Fulda and Werra rivers, are at easily-accessible levels, but the seams are relatively thin; 1.3 -3.5 m. The potassium content is in the range 7 – 15 % K2O. The ore is extracted by conventional mining and the room and pillar method is used in most cases. In the northern Hannover region the potash beds are steeply dipping and folded and the deposits have sometimes the shape of a dome (Ullmann, vol. A 22, 1993). Therefore they are less accessible, but the seam thickness vary between 4 and 30 meters and the K2O content is between 13-14 %, on average 3,5 % higher than the southern deposits. The geological conditions in this region favour the underhand stooping mining system (Phosphorus & Potassium, 1983).

In France beds of potassium-bearing salts extend under the Plain of Alsace. Two sylvinite beds are found in three different basins. The upper bed has a K2O content of 20-27 % and a thickness of about 1.5 meters, while the lower bed which contains 12-20 % K2O is thicker, at about one to five meters. The room and pillar method has been practised for a long time, but in order to increase the mine output longwall is now predominantly used (Fertilizer Manual, 1998).

In the former Soviet Union the potash production is centred around three main regions; the Urals, Belarus and Ukraine (Fertilizer Manual, 1998). The room and pillar method has been extensively used, but nowadays longwall mining is the most frequent system of extraction (Encyclopedia of Chemical Processing and Design, vol. 41, 1992; Ullmann, vol. A 22, 1993).

The room and pillar method has been widely used for mining of potash ore in the United States. However, some mines has been converted to solution mining, e.g. a mine in Utah where conventional mining operations had to be terminated due to severe technological and geological problems (Encyclopedia of Chemical Processing and Design, vol. 41, 1992; Ullmann, vol. A 22, 1993).

In Canada solution mining and the room and pillar method are practised. Mining in Saskatchewan, Canada is relatively clean and straightforward since the evaporite beds are regular, tabular and relatively untilted (Encyclopedia of Chemical Processing and Design, vol. 41, 1992).

Beneficiation of Potash Ore

In order to increase the concentration of potassium chloride to 95 % three different beneficiation techniques are mainly applied in the potash industry; flotation, thermal dissolution-crystallisation or hot leaching and electrostatic separation (Patyk, 1996).

The salt minerals in potash ores are intergrown with other salt minerals to varying extents. The most important minerals are sylvinite, sylvite mixed with halite, and so-called hard salts, sylvite and kieserite (Patyk, 1996). Therefore the ore must be sufficiently reduced in size, so that individual components are accessible, before the minerals can be separated and the useful components recovered. Potash salts are relatively easily size-reduced by grinding. In the hot leaching process potassium chloride is extracted and must therefore not be occluded inside other minerals, which implies an upper grain size limit of 4-5 mm. For the mechanical processes, i.e. flotation and electrostatic separation, liberation of the minerals must be complete, which means that individual grains must consist as much as possible of pure minerals. For German sylvinite ores and hard salts, this is achieved by grinding to a maximum grain size of 0.8-1.0 mm, but for coarser sylvinite ores of, for example, Saskatchewan, Canada a size reduction to < 9 mm would give an adequate liberation (Ullmann, vol. A 22, 1993).

Flotation

Flotation essentially relies on the fact that fresh mineral surfaces can be induced to adopt either a hydrophobic or hydrophilic attitude in the solution by conditioning with specific surface chemicals. Air bubbles are then introduced into the solution and the mineral particles will, if they are hydrophobic, attach themselves to air bubbles at the air/water interface and float up to the top where they can be mechanically removed (Fertilizer Manual, 1998). Common collectors are hydrochloride and acetate salts of aliphatic amides with a carbon chain length of 12-24. Frothers are often added before the slurry enters the flotation cell (Encyclopedia of chemical Processes and Design, vol. 41, 1992). The flotation process has advantages over other processes, in particular the crystallisation process, in that total energy consumption is generally lower and maintenance and equipment depreciation charges generally less than for other comparable processes (Fertiliser Manual, 1998).

Dissolution-Crystallisation or Hot Leaching

The basis of the dissolution-crystallisation method of benificiation, even called the hot leaching process, lies in the fact that potassium chloride is very much more soluble in hot water than in cold, whereas sodium chloride is only slightly more soluble at 100°C than at 20°C. In solutions saturated with respect to both sodium and potassium chloride, sodium chloride is actually less soluble at higher temperatures. Firstly, the sylvinite ore is crushed and washed with cool, saturated sodium/potassium chloride solution. Clay is removed and the clarified solution is then heated and used to dissolve the potassium chloride in the washed ore. Any undissolved sodium chloride is discarded as tailings. Finally, the solution is cooled under vacuum, which results in the crystallisation of potassium chloride and the crystals are separated, washed and dried (Fertilizer Manual, 1998). The remaining brine, mostly sodium chloride, is recirculated and heat exchangers recover valuable heat. A major cost in this process is the heating of the cool mother liquid from the crystalliser before recycling it to the dissolution stage (Phosphorus & Potassium, 1983). However, this method was used before the introduction of flotation in the mid-1930s and it is to prefer when the ores are excessively high in either clay or carnallite (Encyclopedia of Chemical Processes and Design, vol. 41, 1992).

Electrostatic Separation

Electrostatic separation is a dry technique in which a mixture of minerals may be differentiated according to their electrical conductivity. For potash minerals, which are not naturally conductive, the separation must be preceded by a conditioning step that induces the minerals to carry electrostatic charges of different magnitude and, if possible, different polarities. In Germany, the researchers have developed a process for dry beneficiation of complex potash ores. Particle size, conditioning agents, and relative humidity are used in the electrostatic separation zones to separate ore into three fractions (Fertiliser Manual, 1998). The components are separated in stages, using up to four stages and the particles pass direct from one stage to another. The company that has developed this process, Kali und Salz GmbH, is silent about the process, but a stage seems to be two rows of tubes, 25 cm apart and 2.5 m long, at 100 kV direct current. Using this process for beneficiation, all the energy that is consumed when drying out the potash beneficiated by wet means is saved and tailings disposal problems associated with alternative wet separation processes eliminated (Encyclopedia of Chemical Processes and Design, vol. 41, 1992).

Methods of Beneficiation used in Different Countries

In Germany the hot leaching process is the dominating method of beneficiation of potash ores (Ullmann, vol. A 22, 1993). Electrostatic separation is also used to a large extent (Fertilizer Manual, 1998).

Flotation is used at one plant in France and the hot leaching process is practised at the two remaining ones (Fertilizer Manual, 1998; Encyclopedia of Chemical Processes and Design, vol. 41, 1992).

In Spain and in the United Kingdom flotation is used exclusively for the separation of potassium chloride from sodium chloride (Encyclopedia of Chemical Processes and Design, vol. 41, 1992).

In the former Soviet Union the hot leaching process is still a widely used method for beneficiation of potash ores, especially in old plants. Generally the flotation process is used in new installations, except when potash ores contain high levels of clay or when magnesium chloride levels exceed 30 % (Phosphorus & Potassium, 1983).

In Canada and in the United States flotation is predominantly used as the main product process, except for the two solution mines (Encyclopedia of Chemical Processes and Design, vol. 41, 1992). In some plants, especially in Canada small hot leaching plants are also operated, in which product fines are recrystallised or potassium chloride is extracted and crystallised from the flotation residues and clay slurries (Ullmann, vol. A 22, 1993).

Potassium chloride and potassium sulphate are also produced from brines on commercial basis from six sources in the world, including two lakes, the Great Salt Lake in Utah and the Dead Sea between Israel and Jordan; two subsurface brine sources, one in California and one in Utah; two solution mines, one in Utah and one in Saskatchewan, Canada. Potassium sulphate is produced from the Great Salt Lake and the subsurface brine in California and potassium chloride is produced from all brines except the one from Great Salt Lake. Brines from the sources in Saskatchewan and in California are concentrated in multiple-effect evaporators and crystals of the final product are grown in multiple-stage vacuum crystallisers. The brine from the other sources is concentrated by solar evaporation (Encyclopedia of Chemical Processes and Design, vol. 41, 1992).

Environmental Aspects
In addition to the consumption of energy, the main environmental problem of the potash industry is disposal of process waste (Ullmann, vol. A 22, 1993). When processing potash ore to saleable product three types of waste products are generated; liquid and solid salt tailings, insolubles or slimes and dust. Salt tailings are generally the major environmental concern and the composition of the waste depends on the type of ore treated. Waste from sylvinite processing consists mainly of halite, waste from treatment of hard salts are halite and kieserite and from treatment of carnallitic ore are halite and carnallite (Phosphorus & Potassium, 1983; Ullmann, vol. A 22, 1993). Concentrated salt is a toxic waste which does not decay and requires dilution in order to be non-toxic (Phosphorus & Potassium, 1983).

There are four methods for disposing of waste; stacking, backfilling, pumping into the ground and discharge into natural water systems (Ullmann, vol. A 22, 1993). Until recently, plants merely stacked their waste salts and slimes and injected the excess brine underground, or dumped both into the nearest river. New plants have been required to eliminate these practices (Fertlizer Manual, 1998). In case of stacking, measures must be taken so that salt solutions that run off the deposited material, such as solid salt tailings and insolubles, not harm the environment when they are absorbed into the ground. If the ground underneath the stack is not impermeable, layers of clay or plastic sheets must seal it. In Germany, the solid waste is formed into steep conical heaps in order to decrease the amount of run off water formed by rainfall and to minimise the required ground area. If mining methods are suitable and certain geological requirements are met solid waste can be backfilled in the mines. This is the main method of waste disposal in the potash works in the northern Germany, where the salt beds are steeply inclined and this method is also practised in some mines in Canada. However, backfilling is not possible for technical and economic reasons in most potash works (Ullmann, vol. A 22, 1993).

Under certain geological conditions it is possible to pump salt solutions back into the ground. For this purpose the formation used must possess sufficient porosity and permeability and must have no contact with water bearing formations. For example, in the Werra potash region of Germany large quantities of brines have been pumped into a porous dolomite layer. However, in this region the amount of brines produced has decreased drastically since the introduction of electrostatic separation of potash ore. This beneficiation process was developed in the aim of reducing the amount of liquid salt tailings (Ullmann, vol. A 22, 1993). Sea disposal is practised in the United Kingdom (Fertilizer Manual, 1998) and by one of the works in Canada and presents few major problems if the outlet is sufficiently far away from the coast. The potash works on the Dead Sea can dispose waste brine in the Dead Sea itself, without problems since the waste brine is more diluted than the water in the Dead Sea. For most potash works, waste brines must be disposed into natural flowing water since neither underground disposal nor disposal in seawater is possible. This is strictly regulated in most countries, but although, for example, the salt halt in the Werra River, Germany is very high due to the potash works in the eastern part of the Werra region (Ullmann, vol. A 22, 1993).

The only important atmospheric pollution caused by the production of potassium salts is dust emitted from the drying plant and from the handling of the ore and the products (Ullmann, vol. A 22, 1993). Such emissions contain primarily a mixture of potassium chloride and sodium chloride and deposition of the dust may be beneficial or hazardous to soil productivity depending on the level of emissions (Phosphorus & Potassium, 1983).

References:
Encyclopedia of Chemical Processing and Design (1992). Volume 41. p. 155-158.

Fertilizer manual (1998). United Nations Industrial Development Organization (UNIDO) and International Fertilizer Development Center (IFDC). Published by Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

Patyk A (1996). International Conference on Application of Life Cycle Assessment in Agriculture, Food and Non-Food Agro Industry and Forestry: Achievements and Prospects. IFEU-Institut für Energie- und Umweltforschung Heidelberg; Wilkensstrasse 3, D-69120 Heidelberg, Germany.

Phosphorus & Potassium (1983). No 128 November-December 1983.

Ullmann's Encyclopedia of Industrial Chemistry (1993). Volume A 22. p. 47-80.

System Boundaries

Nature Boundary	The system starts with extraction of potash salt and ends with potassium chloride leaving the factory gate. Energy consumption for extraction and emissions from combustion of natural gas are not included.
Time Boundary	The data were given by Kali & Salz in 1998.
Geographical Boundary	The extraction, beneficiation and grinding take place in Germany.
Other Boundaries	Energy consumption for extraction and emissions from combustion of natural gas are not included.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	
Method	The information is taken from personal communication with Mr Aselmeyer at Kali & Salz in Germany.
Literature Reference	Personal communication: Aselmeyer F-B (1998). Kali und Salz GmbH, Kassel, Germany. tel: +49-561-301-2224.
Notes	The consumption of energy is low compared to West European average data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Potash salt				kg	Ground	Germany
Notes: The energy input given by Kali & Salz is stated as being mostly natural gas.	Input	Refined resource	Natural gas	1.4			MJ	Technosphere	Germany
Notes: Potassium chloride (about 60 % K2O)	Output	Product	Potassium chloride	1			kg	Technosphere	Germany

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The dataset is intended to be
General Purpose	To generate an inventory of emissions and use of resources due to the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare production of different fertilisers to each other but to generate a thorough inventory of emissions and use of resources due to the production of fertilisers used in Sweden. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems. Production of potasssium chloride is one step in the line of production of fertilisers containing potassium produced in Sweden.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The dataset is applicable for extraction, beneficiation and grinding of potash salt in Germany. It is included in aggregated datasets for production of fertilisers at Hydro Agri AB in Köping (cradle to gate).
About Data	The data are given by Kali und salz in Germany. No information on process emissions during extraction, beneficiation and grinding was given.

Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Fabrication of oil filters

Administrative	
Finished	Y
Date Completed	2002-12-12
Copyright	
Availability	Public

Technical System	
Name	Fabrication of oil filters
Functional Unit	0.706 kg of filter
Functional Unit Explanation	The oil filter HC 8904 FKP 16Z weighs 0.706 kg.
Process Type	Cradle to gate
Site	Tipperary, Ireland
Sector	Materials and components
Owner	Tipperary, Ireland
Technical system description	Fabrication of oil filters is described in this data set. The filter is used to clean circulating oil in a lubricating system. The oil filter HC 8904 FKP 16Z is made of PA 66, POM and PET, glass and teflon. It is coreless which means that no part of it is made of metal, it is thouroughly plastic.

System Boundaries	
Nature Boundary	The plastic raw material as well as the finished filters comes from the technosphere. Emissions are not included due to lack of data.
Time Boundary	Data is collected autumn 2002. No changes are planned for the nearest future.
Geographical Boundary	The production site is in Ireland.
Other Boundaries	No transports are included.
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	2002-09-01 - 2002-12-31
Data Type	Derived, unspecified
Represents	N/A
Method	Personal communication with Mike Day, Pall Corporation.
Literature Reference	N/A
Notes	none

Flow Table and Specific Meta Data									
QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refine resource	Glass	0.0388			kg	Technosphere	Europe
	Input	Refine resource	PET	0.115			kg	Technosphere	Europe
	Input	Refine resource	Polyamide	0.233			kg	Technosphere	Europe
	Input	Refine resource	POM	0.31			kg	Technosphere	Europe
	Input	Refine resource	TEFLON	0.0084			kg	Technosphere	Europe
	Output	Product	Filter Pall HC 8904 FKP 16Z	0.706			kg	Technosphere	Europe

About Inventory	
Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002. -------------- Data documented by Sandra Häggström, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-03-21.
Intended User	Product developer at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The purpose for our study is to compare a coated roller bearing to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll and is lubricated with a circulating oil system in both cases. The circulating oil is cleaned using filters from Pall, also in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	The data is applicable for coreless oil filters.
About Data	The data is collected by personal communication with Mike Day, Pall Corporation.
Notes	

SPINE LCI dataset: Ferry

Administrative	
Finished	Y
Date Completed	1998 08
Copyright	NTM
Availability	Public

Technical System	
Name	Ferry
Functional Unit	1 tonkm
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers, 80 % for RoRo vessles and 60% for other vessles. This is concidered representative for traffic to/from Sweden. *empty trips are included.*
Process Type	Gate to gate
Site	Sweden
Sector	Sea transport

Owner	Sweden
Technical system description	Operation of ferry, of the type that plies to Denmark and Finland, with a utilisation level of 60% by weight.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1999.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers, 80% for RoRo vessles and 60% for other vessles 60% (including empty trips) *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	The energy use and emissions have been allocated between passengers and goods according to a method described in Sjöbris A. Flodström, E.''Emissions och energivärderingsprinciper för transportsystem'' KFB rapport 1994:9, 1994 The method is based on the argument that if there were no passengers, the cargo would be transported with a RoRo vessel of the same size. The goods is charged with the amount of energy use and emissions if it had been transported with a RoRo vessel of the same size, and the passengers are charged with the remaining energy use and emissions. The cargo then account for approx. 20 % of the total energy use and emissions of the ferry.
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 09
Data Type	Derived, unspecified
Represents	NTM
Method	All vessels larger than 300 tons gross tonnage in the Swedish Shipowners' Association's register have been used as a basis for the data For each individual ship, the load capacity (in dwt), installed engine effect (in kW) (Redareföreningen 1995) and speed (in knots) have been used as a basis. The emissions have been calculated on the basis of the distribution of low and high revolution engines among the different size classes, and the emission factors of the engines (Alexandersson et al 1991), see table below. The energy use has been calculated with the assumption of an oil consumption of 200 g/kWh for both low and medium revolution engines. The emisson factors below are given in g/kWh, where kWh refer to mechanical work done by the engine. Engine type Load NOx CO CO2 THC PM Low rev 80% 17,7 0,2 600 0,8 0,9 Medium rev 80% 14 1 620 0,2 0,4 The utilisation levels used in these calculations are as follows: Tank 0,5 Bulk 0,6 RoRo 0,8 LoLo 0,6 Ferry 0,6 Others 0,6 The calculations of emissions from shipping are made according to the following principle: emission factor = spec.emission x effect x 1 x 1 speed load capacity utilisation level The *quantity value* for all parameters is an average of all vessels in the population. The *minimum value* corresponds to the individual with the lowest energy use and emissions in the population, and the *maximum value* to the individual with the largest energy use and emissions in the population.
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Demker, G. et al. *Miljöeffekter av transportmedelsval för godstransporter*, MariTerm, KFB-rapport, 1994:6 *Skeppsregister 1995*, Swedish Shipowner Association Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 *Lloyds list*, 1996
Notes	The energy use and emissions from ferries vary greatly. The result depend on calculation method, size of the ship, speed, route, age of the ship, fuel etc. Swedish Shipowners Assossiation are working on an updated and more detailed version of emission data from ferries.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Heavy oil	0.11	0.019	0.22	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.049	0.00880	0.101	g	Air	Sweden
	Output	Emission	CO2	30.6	5.4	62.4	g	Air	Sweden
	Output	Emission	HC	0.010	0.0018	0.020	g	Air	Sweden
Method: The emissions per tonkm are calculated from standard values for the specific emissions for two-stroke and four stroke engines at 80 % engine load. The standard values are given in g/kWh, where kWh refer to mechanical work done by the engine. The following *equation* was used to calculate the emissions per tonkm for each vessel: (spec. emission factor[g/kWh]*engine power[kW])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** *Specific emission factors:* The emission factors were given in Alexandersson and are based on measurements on the engine. Two stroke engines at 80 % engine load: -CO2 600 g/kWh -NOx 17,7 g/kWh -HC 0,8 g/kWh -CO 0,2 g/kWh -Particles 0,9 g/kWh Four stroke engines at 80 % engine load: -CO2 620 g/kWh -NOx 14 g/kWh -HC 0,2 g/kWh -CO 1 g/kWh -Particles 0,4 g/kWh See General QMetadata for further details.	Output	Emission	NOx	0.691	0.123	1.41	g	Air	Sweden
	Output	Emission	Particles	0.0198	0.00350	0.0403	g	Air	Sweden
	Output	Emission	SO2	0.099	0.0175	0.201	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value

	since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Sörheim, Elisabet - Swedish Shipowners Association .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vessel, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association or from the operators. ***Type of vessels*** *Cargo Vessles* - includes all vessels except RoRo vessels and ferries. Cargo Vessles thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc. Cargo Vessles are mainly used for transportation of heavy goods over large distances. The energy use for tankers is generally lower than for other Cargo vessles. *RoRo vessels* are used for transportation of different types of load carriers such as trailers, containers etc. The cargo is rolled on the vessel. RoRo vessels generally operate at a higher speed than regular Cargo vessles. *Ferries* carry both passengers and goods. The goods are carried in trucks, trailers or trains. ***Fuel*** The fuel quality vary to a large extent between different vessels. Smaller vessels that only operate on Swedish routes generally use cleaner fuels. The main part of freighters in Swedish traffic use heavy fuel oil, with a sulphur content of 2,6 %. Small coastal freighters may however use gas oil with sulphur content of 0,1 %. Gas oil is the most refined type of fuel used in vessels (the maximum sulphur content is 1,5 %). In ferries, low sulphur fuel with sulphur content of 0,5 % is generally used. ***Reduction of emissions*** The data does not assume the use of any emission reducing measures. Different measures may be taken to reduce the emissions, e.g. water injection may reduce the emissions of NOx by 50%, and adjustments of the engine may reduce NOx emissions by 30 %. Catalytic converters may reduce NOx emissions by 90-100% and HC by 70-80%. Emissions of particles and HC are also reduced. Installation of catalytic converters is however a large investment for the shipowners. There are at present only a few vessels in Swedish traffic that has installed catalytic converters. The other measures constitute a smaller investment, and it is anticipated that the shipowners will chose these techniques to reduce emissions. ***Bulky goods*** Vessels generally handle transportation of large heavy goods over long distances. Some bulky goods are however transported by sea, primarily by RoRo vessels and ferries. The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Travelled distance*** The travelled distance of the goods may be estimated using a Nautic almanac, Lloyd. Since the utilisation level includes empty trips, no compensation in the distance for empty trips needs to be done. ***International sea transports*** When using the data for international traffic, the sulphur emissions should be adjusted, since the fuel quality may vary. Representative sulphur content of fuel used in international traffic is 3,3 %. The energy use and emissions of other parameters may also vary to a large extent depending on the quality of the fuel. The utilisation levels used in these calculations are as follows: Tank 0,5 Bulk 0,6 RoRo 0,8 LoLo 0,6 Ferry 0,6 Others 0,6

About Data	Data have been calculated on the basis of the load capacity (in dwt), installed engine effect (in kW) (Redareföreningen) and speed (in knots) (Lloyds) of each individual ship. Emissions to air per tonkm have been calculated by using the emission factors of the engines (Alexandersson et.al. 1991), see table below, and by knowing the relation of low and medium revolution engines to different sizes of ships. The emisson factors below are given in g/kWh, where kWh refer to mechanical work done by the engine. Engine type Load NOx CO CO2 THC PM Low rev 80% 17,7 0,2 600 0,8 0,9 Medium rev 80% 14 1 620 0,2 0,4 The energy consumption has been calculated by the assumption of an oil consumption of 200g/kWh for both low and medium revolution engines. The sulphurous content of the fuel is assumed to be 0.5% for ferries (Sjöbris 1994). N.B. In this example, the load carrier is also counted as load! See also: Allocations.
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by boat in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Ferry, 700-7000 tonnes

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Ferry, 700-7000 tonnes
Functional Unit	1 tonkm, 60 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 60%. An utilisation level of 60% is representative for Swedish domestic traffic if *empty trips are included.*
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of Swedish flagged ferries carrying both passengers and cargo, which are members of the Swedish Shipowners´ Association. The loading capacity is 700 - 7000 tonnes.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 60% (including empty trips). *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	The energy use and emissions have been allocated between passengers and goods according to a method described in Sjöbris A. Flodström, E.''Emissions och energivärderingsprinciper för transportsystem'' KFB rapport 1994:9, 1994 The method is based on the argument that if there were no passengers, the cargo would be transported with a RoRo vessel of the same size. The goods is charged with the amount of energy use and emissions if it had been transported with a RoRo vessel of the same size, and the passengers are charged with the remaining energy use and emissions. The cargo then account for approx. 20 % of the total energy use and emissions of the ferry.
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1990-01-01 - 1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The basis for the data are all Swedish flagged ferries, which are members of the Swedish Shipowners' Association. The *quantity value* for all parameters is an average of all vessels in the population. The *minimum value* corresponds to the individual with the lowest energy use and emissions in the population, and the *maximum value* to the individual with the largest energy use and emissions in the population. The *utilisation level* with regard to weight is 60%, based on Demker et al. The data is allocated between the passengers and goods, 20 % of the energy use and emissions were allocated to the goods (for further information see Allocations). The energy use and emissions per tonkm for each vessel was calculated (see Specific QMetaData for each flow). For each vessel, the loading capacity was stated in deadweight tonnes (Skeppsregister 1995), installed engine power in kW (Skeppsregister 1995) and speed in knots (Lloyds list). The share of two-stroke and four-stroke engines in each vessel was determined by the size of the vessel according to Alexandersson. All vessels in the population were then used to calculate an average value.
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Demker, G. et al. *Miljöeffekter av transportmedelsval för godstransporter*, MariTerm, KFB-rapport, 1994:6 *Skeppsregister 1995*, Swedish Shipowner Association Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 *Lloyds list*, 1996
Notes	The energy use and emissions from ferries vary greatly. The result depend on calculation method, size of the ship, speed, route, age of the ship, fuel etc. Swedish Shipowners Assossiation are working on an updated and more detailed version of emission data from ferries.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The oil consumption per	Input	Refined resource	Heavy oil	0.4	0.07	0.81	MJ	Technosphere	

tonkm were calculated using assumptions on the oil consumption for two stroke and four stroke engines (g/kWh, where kWh refer to mechanical work done by the engine). The following *equation* was used to calculate the oil consumption per tonkm for each vessel: (oil consumption[g/kWh]*installed engine power[kW]*thermal value[MJ/kg])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** -Oil consumption: 200 g/kWh for both two-stroke and four-stroke engines (based on Alexandersson). -Thermal value for the oil: 40 MJ/kg. See General QMetaData for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Notes: Modern engines have lower fuel consumption (down to 160g/kWh for slow speed engines).									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.0494	0.0088	0.1007	g	Air	
Method: See QMetaData for NOx	Output	Emission	CO2	31	5.4	62	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.0099	0.0018	0.0201	g	Air	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm are calculated from standard values for the specific emissions for two-stroke and four stroke engines at 80 % engine load. The standard values are given in g/kWh, where kWh refer to mechanical work done by the engine. The following *equation* was used to calculate the emissions per tonkm for each vessel: (spec. emission factor[g/kWh]*engine power[kW])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** *Specific emission factors:* The emission factors were given in Alexandersson and are based on measurements on the engine. Two stroke engines at 80 % engine load: -CO2 600 g/kWh -NOx 17,7 g/kWh -HC 0,8 g/kWh -CO 0,2 g/kWh -Particles 0,9 g/kWh Four stroke engines at 80 % engine load: -CO2 620 g/kWh -NOx 14 g/kWh -HC 0,2 g/kWh -CO 1 g/kWh -Particles 0,4 g/kWh See General QMetadata for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18	Output	Emission	NOx	0.69	0.12	1.4	g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.0198	0.0035	0.0403	g	Air	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the fuel. The following *equation* was used to calculate the emission for each vessel: 2*(oil consumption[g/kWh]*engine power[kW]* sulphur content)/(speed[km/h]*loading capacity[ton]*occupation) ***Data used in the calculations:*** -Sulphur content: 2,6 % (Sjöbris). -Oil consumption: 200 g/kWh for both two-stroke and four-stroke engines (Alexandersson). See General QMetaData for further details. Literature: Alexandersson, A.,	Output	Emission	SO2	0.099	0.018	0.2	g	Air	

Sjöfartens utsläpp av avgaser, MariTerm, TFB-rapport 1991:18 Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 Notes: The average sulphur content for oil used in international traffic is 3,3 %. (Alexandersson)								

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 --- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Elisabeth Sörheim, Swedish Shipowners' Association, contact person for sea transports in the work of NGM ---
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Sörheim, Elisabeth - The Swedish Shipowners Association, Box 53046, S-400 14 Göteborg .
Reviewer	
Applicability	*The data should be used with great care.* The distribution between goods and passengers may vary to a large extent between different ferries. The choice of allocation will have a large influence on the data. ***The Swedish Shipowners´ Association recommends that data for RoRo vessels should be used when considering transport by ferry.*** The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vessel, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association. ***Type of vessels*** *Freighters* - includes all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc. Freighters are mainly used for transportation of heavy goods over large distances. The energy use for tankers is generally lower than for other

	freighters. *RoRo vessels* are used for transportation of different types of load carriers such as trailers, containers etc. The cargo is rolled on the vessel. RoRo vessels generally operate at a higher speed than regular freighters. *Ferries* carry both passengers and goods. The goods are carried in trucks or trains. ***Fuel*** The fuel quality may vary to a large extent between different vessels. Smaller vessels that only operate on Swedish routes generally use better fuels. The main part of freighters in Swedish traffic use heavy fuel oil, with a sulphur content of 2,6 %. Small coastal freighters may however use gas oil with sulphur content of 0,1 %. Gas oil is the most refined type of fuel used in vessels (the maximum sulphur content is 1,5 %). In ferries, low sulphur fuel with sulphur content of 0,5 % is generally used. Differentiated harbour dues on sulphur and NOx emissions were introduced in Sweden 1 January 1998. This will probably result in use of fuels of a better quality, primarily in ferries but also other freighters. ***Reduction of emissions*** The data does not assume the use of any emission reducing measures. Different measures may be taken to reduce the emissions, e.g. water injection may reduce the emissions of NOx by 50%, and adjustments of the engine may reduce NOx emissions by 30 %. Catalytic converters may reduce NOx emissions by 90-100% and HC by 70-80%. Emissions of particles and HC are also reduced. Installation of catalytic converters is however a large investment for the shipowners. There are at present only a few vessels in Swedish traffic that has installed catalytic converters. The other measures constitute a smaller investment, and it is anticipated that the shipowners will chose these techniques to reduce emissions. ***Bulky goods*** Vessels generally handle transportation of large heavy goods over long distances. Some bulky goods are however transported by sea, primarily by RoRo vessels and ferries. The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Travelled distance*** The travelled distance of the goods may be estimated using a Nautic almanac, Lloyd. Since the utilisation level includes empty trips, no compensation in the distance for empty trips needs to be done. ***International sea transports*** When using the data for international traffic, the sulphur emissions should be adjusted, since the fuel quality may vary. Representative sulphur content of fuel used in international traffic is 3,3 %. The energy use and emissions of other parameters may also vary to a large extent depending on the quality of the fuel.
About Data	The data for emissions is derived from specific emission factors for the engine at a constant 80 % engine load. No test cycle was used to obtain the emission factors. There is however a small need for test cycles, since vessels generally operate at constant load on the engine during the sail. The fact that the engine load sometimes is lower than 80 % i.e. when sailing to and from the harbour has been neglected. This part is generally small but complicated. The calculation model may be used to calculate the energy use and emissions for a specific vessel if the loading capacity, installed engine power etc. is known. This information may be obtained from Skeppsregister. See QMetaData for details.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Ferry, 700-7000 tonnes, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Ferry, 700-7000 tonnes, future
Functional Unit	1 tonkm, 60 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 60%. An utilisation level of 60% is representative for Swedish domestic traffic if *empty trips are included.*
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of Swedish flagged ferries carrying both passengers and cargo with new technology reducing the energy use and emissions (catalytic converters, energy saving measures etc.) Only members of the Swedish Shipowners´ Association are included. The loading capacity is 700 - 7000 tonnes.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents new technology, available today but not yet in regular use.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 60% (including empty trips). *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	The energy use and emissions have been allocated between passengers and goods according to a method described in Sjöbris A. Flodström, E..''Emissions och energivärderingsprinciper för transportsystem'' KFB rapport 1994:9, 1994 The method is based on the argument that if there were no passengers, the cargo would be transported with a RoRo vessel of the same size. The goods is charged with the amount of energy use and emissions if it had been transported with a RoRo vessel of the same size, and the passengers are charged with the remaining energy use and emissions. The cargo then account for approx. 20% of the total energy use and emissions of the ferry.
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1997-01-01

Data Type	Derived, unspecified
Represents	NTM
Method	The energy use and emissions was calculated using *assumptions* on energy saving and emission reducing actions together with data for existing individual vessels with the *lowest energy use and emissions* within the population of Swedish flagged ferries, which are members of the Swedish Shipowners' Association. The utilisation level with regard to weight is 60 %. The data is allocated between the passengers and goods, 20 % of the energy use and emissions were allocated to the goods (for further information see Allocations). The assumptions were given by the Swedish Shipowners' Association. The data for energy use and emissions for the vessels that was the basis for the calculation, and a description on how the data was obtained, can be found in the activity with ObjectOfStudy.Name: *Ferry, 700-7000 tonnes* (in this database) or in ''Energi- och emissionsuppgifter för godstransporter''. The minimum value for the energy use and emissions was used in the calculation. The following percentages for the reduction of energy use and emissions was used in the calculation: -Oil consumption: 30 % (by different energy saving measures) -NOx: 93 % (through optimisation of the engine and catalytic converters) -HC: 88 % (by catalytic converters) -CO: 81 % (by catalytic converters) -Particles: 35 % The sulphur content in the fuel was assumed to be 0,09 %. Emissions of SO2 were calculated from the fuel consumption using the sulphur content in the fuel. Emissions of CO2 were calculated from the fuel consumption using the carbon content in the fuel.
Literature Reference	Energi- och emissionsuppgifter för godstransporter i Sverige, Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning 1997, NGM- Nätverket för Godstransporter och Miljön.
Notes	The energy use and emissions from ferries vary greatly. The result depend on calculation method, size of the ship, speed, route, age of the ship, fuel etc. Swedish Shipowners Assossiation are working on an updated and more detailed version of emission data from ferries.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Heavy oil	0.049			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	0.0017			g	Air	
	Output	Emission	CO2	3.8			g	Air	
	Output	Emission	HC	0.0002			g	Air	
	Output	Emission	NOx	0.004			g	Air	
	Output	Emission	Particles	0.0023			g	Air	
	Output	Emission	SO2	0.0032			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Elisabeth Sörheim, Swedish Shipowners' Association, contact person for sea transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives.

	The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Sörheim, Elisabeth - The Swedish Shipowners Association, Box 53046, S-400 14 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions for Swedish flagged ferries. The data represents new technology (catalytic converters, energy saving measures etc), not yet in regular use. There are at present only a few vessels in Swedish traffic that has installed catalytic converters, since installation of catalytic converters is a large investment for the shipowners.
About Data	The data is based on assumptions on different energy saving and emission reducing actions together with data for existing vessels in Swedish traffic with the lowest energy use and emissions. The data was compiled by the Swedish Shipowners´ Association. See Flow QMetaData for further information.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Fertilizing in silviculture

Administrative	
Finished	Y
Date Completed	1994-02-24
Copyright	Open
Availability	Open

Technical System	
Name	Fertilizing in silviculture
Functional Unit	ha
Functional Unit Explanation	Per ha fertilized forest land.
Process Type	Gate to gate
Site	Sweden
Sector	Forestry
Owner	Sweden

Technical system description	Fertilizing is in industrial silviculture made 1 -3 times. This step describes one fertilization. The reason is to increase the growth rate during some years. The spreading is performed with tractor (14%) and helicopter (86%). Assumed is that SKOG-CAN 27,2 % N is used (presented as N-fertilizer).

System Boundaries	
Nature Boundary	Emissions from combustion of fuels are not included.
Time Boundary	The data collected are representative for the time period 1992-1994.
Geographical Boundary	Sweden
Other Boundaries	Production and distribution of fertilizer is not included.
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1994-02-24
Data Type	Unspecified, expert outspoke
Represents	
Method	Personal communication with U. Hallonborg. Further information is available for each specific flow.
Literature Reference	U. Hallonborg, Skogforsk
Notes	The energy use and emissions from ferries vary greatly. The result depend on calculation method, size of the ship, speed, route, age of the ship, fuel etc. Swedish Shipowners Assossiation are working on an updated and more detailed version of emission data from ferries.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Represents: Spreading with tractor. Method: The spreading is made with helicopter (86 % of total area, 504 MJ/ha) and tractor (14%, 1570 MJ/ha). Per ha 0,86*504=433 MJ helicopter fuel + 0,14*1570=220 MJ/ha diesel.	Input	Refined resource	Diesel	220			MJ	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Represents: Spreading with helicopter. Method: The spreading is made with helicopter (86 % of total area, 504 MJ/ha) and tractor (14%, 1570 MJ/ha). Per ha 0,86*504=433 MJ helicopter fuel + 0,14*1570=220 MJ/ha diesel.	Input	Refined resource	Kerosene	433			MJ	Technosphere	Sweden
Date concieved: 94-02-24 Data type: Unspecified, expert outspoke Represents: Input of the fertiliser. Method: The input of fertiliser is the net input of effective nitrogen. The fertiliser is transported by truck at an average one-way distace of 200 km.	Input	Refined resource	Nitrogen fertiliser	150			kg	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Derived from the step: Clearing of young forest	Input	Refined resource	Young forest area	1			ha	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke	Output	Product	Fertilized forest area	1			ha	Technosphere	Sweden

About Inventory	
Publication	None -- Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology

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Intended User	LCA practioners
General Purpose	The purpose is to supply with LCA-data for forestry to be used in further studies of wood products.
Detailed Purpose	These data are an update of earlier data on the same subject. Can also be used as an average for Sweden.
Commissioner	- Stora Corporate Research, Box 601 661 29 Säffle Sweden.
Practitioner	Swan, Göran - Stora Corporate Research, Box 601, S-661 29 Säffle, Sweden.
Reviewer	
Applicability	These data are valid for large scale nursery in forestry. It is important to check the type of fuel used. In this case, fossil fuel is assumed to be used. Other data is available from other forest companies, or from Skogforsk, or STFI. The silviculture process in Sweden has eight steps: 1. Plant nursing 2. Soil preparation 3. Planting 4. Clearing 5. Thinning 6. Fertilizing 7. Final felling 8. Forwarding This is the first step. Different forest owners use the two spreading methods to different extents.
About Data	
Notes	

SPINE LCI dataset: Final felling

Administrative	
Finished	Y
Date Completed	1998-02-13
Copyright	None
Availability	Public

Technical System	
Name	Final felling
Functional Unit	ha
Functional Unit Explanation	Per hectare forest that is being finally felled.
Process Type	Gate to gate
Site	Middle Sweden
Sector	Forestry
Owner	Middle Sweden
Technical system description	Final felling is the final activity in siviculture before the forest area is reforestated. Sometimes a shield of old trees are left for two reasons: 1) Climal protection for young tree plants. 2) Seeding puposes. 3) Added value of the old trees. In this case all wood is assumed to be taken at the same time.

System Boundaries	
Nature Boundary	Emissions caused by combustion of fuels is not included.
Time Boundary	The data collected are representative for the time period 1992-1994.
Geographical Boundary	Central Sweden
Other Boundaries	N/A
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData	
Date Conceived	1994-02-24
Data Type	Unspecified, expert outspoke
Represents	
Method	See specific QMetaData
Literature Reference	U. Hallonborg, Skogforsk
Notes	The energy use and emissions from ferries vary greatly. The result depend on calculation method, size of the ship, speed, route, age of the ship, fuel etc. Swedish Shipowners Assossiation are working on an updated and more detailed version of emission data from ferries.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: 1,0 l diesel per m3sub with the energy contents of 35,6 MJ/l, leaves 37,7 MJ/m3sub, or 15094 MJ/ha	Input	Refined resource	Diesel	15094			MJ	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Derived from Thinning of forest area	Input	Refined resource	Thinned forest area	1			ha	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: According to Skogforsk 300 of the total 400 m3sub/ha are taken out during final felling. Of these 60% are used for pulping and 40% for sawmills.	Output	Product	Final felling softwood	300			m3 fub	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke	Output	Product	Forest land	1			ha	Technosphere	Sweden

About Inventory

Publication	None -- Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioner
General Purpose	The purpose is to supply with LCA-data for forestry to be used in further studies of wood products.
Detailed Purpose	These data are an update of earlier data on the same subject. To be used in LCA representing the final felling part of forestry in central Sweden. Can also be used as an average for Sweden.
Commissioner	- Stora Corporate Research, Box 601 661 29 Säffle Sweden.
Practitioner	Swan, Göran - Stora Corporate Research, Box 601, S-661 29 Säffle, Sweden.

Reviewer	
Applicability	These data are valid for large scale final felling in forestry. It is important to check the type of fuel used. In this case, fossil fuel is assumed to be used. Other data is available from other forest companies, or from Skogforsk, or STFI. The silviculture process in Sweden has eight steps: 1. Plant nursing 2. Soil preparation 3. Planting 4. Clearing 5. Thinning 6. Fertilizing 7. Final felling 8. Forwarding This is the seventh step.
About Data	N/A
Notes	

SPINE LCI dataset: Finland, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Finland, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Finland
Sector	Energyware
Owner	Finland
Technical system description	The generation of electricity with different power generating systems in Finland during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	1153			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	15051			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	21853			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	23			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	4936			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	8595			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	8823			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	9735			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	70169			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow.

	When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Flame laminate treatment of textiles

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Flame laminate treatment of textiles
Functional Unit	m2
Functional Unit Explanation	1 m2 flame laminated textile
Process Type	Gate to gate

Site	Texla Industri AB Trankärrsgatan 13 425 37 Hisings-kärra Sweden
Sector	Materials and components
Owner	Texla Industri AB Trankärrsgatan 13 425 37 Hisings-kärra Sweden
Technical system description	Melting of polyuretan foam, under open flame, and attaching it to textiles.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires. The raw materials, such as textiles, used in the production is not mentioned.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	
Method	Study Environmental Report. The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1996, which was 2460000 m3 laminated textiles.
Literature Reference	Environmental report from Texla Industri AB for 1996, The Environmental Administration in the municipality of Göteborg.
Notes	The data type unspecified implies that one does not know the origin of the data. The material, which is treated in the laminate process, is not mentioned as input in the flow table. The method is specified for the emissions.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1996 Data type: Unspecified Notes: Used as fuel	Input	Refined resource	Propane	0.002764228			kg	Technosphere	
Date concieved: 1996 Notes: Environmental information: In the manufacturing of Polyurethane TDI (Isocyanate) is used.	Input	Refined resource	PU	0.00703252			m3	Technosphere	
Date concieved: 1996 Data type: Random sample Method: It is an average value from 29 samples. At each taking of specimens a filter of 1000 m2 was used. Notes: Dust is emitted with the somke gas.	Output	Emission	Particles	0.0000288618			kg	Air	
Date concieved: 1996 Data type: Random sample Method: It is an average value from four samples. At each taking of specimens a filter of 1000 m2 was used. Notes: TDA is emitted in the smoke gas.	Output	Emission	TDA	0.00000406504			kg	Air	
Date concieved: 1996	Output	Product	Laminated textile	1			m2	Technosphere	
Date concieved: 1996 Notes: Mixed with grime. The public cleansing department disposes the ashes (and grime).	Output	Residue	Ashes	0.000127236			kg	Technosphere	

Date concieved: 1996 Notes: Other rest products are textiles, paper and polythene. The textiles consist of cotton, polyurethane, PVC and Polyamide. The public cleansing department disposes these rest products	Output	Residue	Other rest products	0.0548780488			kg	Technosphere	
	Output	Residue	Wood	0.00162601626			kg	Technosphere	

About Inventory

Publication	Environmental report from Texla Industri AB for 1996, The Environmental Administration in the municipality of Göteborg. -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Bengtsson, Bengt - Texla Industri AB Trankärrsgatan 13 425 37 Hisings-kärra Sweden.
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	The function of the system is not very well described, contact the company for more information. The raw materials, such as textiles, used in the production is not mentioned.
About Data	No margin of error is found in the report, and one can assume that a lot of values have been rounded. The values often end with zeroes and occasionally are indicated to be an approximation.
Notes	

SPINE LCI dataset: Flame retardant polyester (Trevira CS) covering of sofa. ESA-DBP

Administrative

Finished	Y
Date Completed	2004
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Flame retardant polyester (Trevira CS) covering of sofa. ESA-DBP
Functional Unit	''The functional unit was: surface covering of a 3-seat sofa for private use during 10 years.'' For Trevira CS fabric it is 3.56 kg per sofa.
Functional Unit Explanation	See 'Function'.
Process Type	Cradle to grave
Site	Not applicable

Sector	Consumer goods
Owner	Not applicable
Technical system description	The system is descibed in ''Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector - a case study concerning fabrics for a sofa. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden'': http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2004--7.pdf Other processes in the CPM Database also included in the above publication: 'Cotton (conventional) fibres production. ESA-DBP', 'Cotton covering of sofa. ESA-DBP ' and 'Wool/polyamide covering of sofa. ESA-DBP'. ''The function was to provide a surface covering for a sofa. The color of the fabric was red. Six laundry washings for the Trevira CS fabric were assumed in order to see the relative environmental importance of the cleaning step. It was assumed that the fabric could be readily removed from the sofa. Incineration at disposal of the fabric used was assumed in the base case (the most probable life cycle chains). Heat recovery and emissions from the incineration were taken into account, but possible oil saving or replacement of other waste in the incinerator was only tested in the sensitivity analysis.'' ''Trevira CS is a flame retardant fiber. The flame retardance is obtained through co-polymerization of the monomers with O-Phospholane (Neckelmann 2001). In figure 3 (in the above publication) the different companies and their role in the production of Trevira CS fabric are shown. The monomers are terephtalic acid and ethylene glycol. The catalyst is antimony trioxide (possibly carcinogenic to humans (Ellebäk Laursen et al 1997)). This polymerisation is, for instance, done by the Trevira group in their factory in Guben, Germany. The Trevira group also has a factory in Portugal. The spun yarn was assumed to be only filament yarn. For fabrics used on sofas, filament yarn is the main type in the case of Trevira CS.'' In the litterature reference following processes are included: - Production of Trevira CS filament yarn - Truck from production site of Trevira CS yarn to texturing and dyeing site - Texturing - Dyeing of the yarn - Truck and freighter from yarn texturer and dyer to Swedish weaving mill - Weaving without sizing in Sweden - Business trips from Trevira CS weaving mills site - Truck from weaving mill to wet treatment plant - Thermofix (the fabric is fixated with vapor) - Truck from Swedish wet treatment plant back to weaving mill - Textile distribution at weaving mill in Sweden - Truck from Swedish weaving mill to upholstery plant - Upholstering of Trevira CS fabric on a 3-seat sofa - Laundry of Trevira CS fabric - Truck from user to incineration plant - Incineration of Trevira CS fabric

System Boundaries

Nature Boundary	''Mineral resources and water were traced back to their reserves in nature and emissions were followed to air, water or soil. Below are the exceptions found, when the processes were not traced back to the nature reserves or water, or followed to air, water or ground. - A wastewater-treatment plant was included, but the decomposition of each individual chemical was not studied. - The production of the process chemicals and some packaging materials were not within the system boundaries.''
Time Boundary	''Data were collected by interviews from 1999 to 2002, but data from reports ranged from 1993 to 1998. Most reports were from 1997.''
Geographical Boundary	''Trevira CS: *production of Trevira CS polymer fibers: Germany *production of Trevira CS filament yarn and dyeing of the fibers: Denmark *weaving, finishing, upholstering, use and incineration: Sweden''
Other Boundaries	''The fabrics were assumed to not to be worn out before they were disposed of, a realistic scenario for Swedish conditions. Therefore the abrasion resistance was not taken into consideration in the study, while the effect of different lifetimes of the fabrics is discussed in chapter 4.3.7.'' ''Production of Trevira CS filament yarn The plant has its own wastewater-treatment. The COD reported was assumed to be measured after the wastewater-treatment, therefore the water is assumed to go to water and not the technosphere. The yarn is wound onto a spool. 20-30 kilos are on one spool and the spools are reused (or sent for recycling), therefore they are not reported. General energy use was not reported. The travel at work is not known, but is probably insignificant. - Data source: average production data in Europe. The data are a weighted average based on production volumes of 7 different plants in Germany, Austria and the Netherlands (about 30% of total European production). Probably no general energy or water consumption was

	included. In this LCA study for fabrics, discharges to water were assumed to end up in water. - Data includes production of the yarn. There are several types of yarn manufacturing, and filament or staple yarn is the product.'' ''Texturing The cardboard rolls were assumed to be reused many times, and they were therefore left out. 20-30 kg yarn is wound onto a spool.'' ''Truck and freighter from yarn texturer and dyer to Swedish weaving mill The distance by boat was assumed to 40 km and by truck to 300 km. The freighter was assumed to medium size (2000-8000 dead weight tons), Load factor: 60%.'' ''Business trips from Trevira CS weaving mills site The travel distance was calculated to 0.93 vkm/kg fabric.'' ''Truck from weaving mill to wet treatment plant The distance was assumed to 30 km.'' ''Thermofix (the fabric is fixated with vapor) - Data were estimated from one wet treatment plant, and literature values for a comparison are found below. The plant uses light fuel oil and water to generate steam. Unfortunately, only total water and energy use was known and the plant has many different activities. The calculation based on weight gave the value 23 MJ for use of light fuel oil, which is much higher than the literature data. Another plant uses LPG, but that plant had no data about gas and water consumption. One plant uses industrial water and the other uses water from a well. - According to Ellebäk Laursen et al (1997) finishing (a process where properties of the fabric are changed, often with chemicals) uses 4.05-8.00 MJ/kg fabrics. Dyeing, washing and drying uses 3.40-13.2 MJ/kg. Therefore, the estimated 8 MJ/kg seems realistic. The water consumption in the inventory was estimated from the plant. - Amount of cardboard is for the rolls and comes from one wet treatment mill.'' ''Truck from Swedish wet treatment plant back to weaving mill The distance was assumed to 30 km.'' ''Truck from Swedish weaving mill to upholstery plant The distance was assumed to 500 km.'' ''Laundry of Trevira CS fabric The difference as compared laundering of cotton is that the load factor in the washing machine was assumed to 2/3 according to instructions from Electrolux (1996). Tumble-drying was assumed to be one third of the time for cotton tumble-drying.'' ''Truck from user to incineration plant The distance to the incineration plant was assumed to 25 km.''
Allocations	''The allocation procedure by mass was not uniform in applications. The deviations were as follows: - No flows were allocated to waste, such as edge strips from weaving or cardboard or textile samples. - In the weaving operation, allocation was made per meter fabric. - Allocations for light fuel oil, heavy fuel oil, LPG and natural gas production were not known as well as for electricity from natural gas or oil and production of sodium hydroxide and ethylene glycol used for the sensitivity analysis. - For electricity production (Swedish average) the allocation between recycling and virgin materials was according to the 50/50 method. When heat was also produced, the allocation was according to energy output. - For electricity (European average), exergy values were used to allocate between electricity and heat.''
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	Unknown
Data Type	Calculated
Represents	See 'Function'.
Method	The data is produced with the software tool LCAit.
Literature Reference	Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector - a case study concerning fabrics for a sofa. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2004-7.pdf
Notes	This data set is generated with the software LCAit. All values that are below 0.001 kg and values given in the unit Bq are excluded. These values can be found in the litterature reference.

Flow Table and Specific Meta Data									
QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Acetic acid	0.0389			kg	Technosphere	
	Input	Refined resource	AE	0.0684			kg	Technosphere	
	Input	Refined resource	Cardboard	0.169			kg	Technosphere	
	Input	Refined resource	CMC	0.0085			kg	Technosphere	
	Input	Refined resource	DAS-1	0.0017			kg	Technosphere	
	Input	Refined resource	Dispersant	0.0216			kg	Technosphere	
	Input	Refined resource	Dyeing agents	0.128			kg	Technosphere	
	Input	Refined resource	Enzyme	0.00425			kg	Technosphere	
	Input	Refined resource	Even out agent	0.0756			kg	Technosphere	
	Input	Refined resource	FeSO4	0.0358			kg	Technosphere	
	Input	Refined resource	LAS	0.085			kg	Technosphere	
	Input	Refined resource	Lime	0.0022			kg	Technosphere	
	Input	Refined resource	Lubricant oil	0.00108			m3	Technosphere	
	Input	Refined resource	Na carbonate	0.0854			kg	Technosphere	
	Input	Refined resource	Na perborate	0.128			kg	Technosphere	
	Input	Refined resource	Na sulphate	0.107			kg	Technosphere	
	Input	Refined resource	Other fuel	7.66			MJ	Technosphere	
	Input	Refined resource	Paper	0.0176			kg	Technosphere	
	Input	Refined resource	Phosphonate	0.0085			kg	Technosphere	
	Input	Refined resource	Polycarboxylate	0.0214			kg	Technosphere	
	Input	Refined resource	Soap	0.0255			kg	Technosphere	
	Input	Refined resource	Sodium hydro sulphite	0.0864			kg	Technosphere	
	Input	Refined resource	Sodium hydroxide	0.134			kg	Technosphere	
	Input	Refined resource	Sodium silicate	0.0907			kg	Technosphere	
	Input	Refined resource	Sulphuric acid	0.00367			kg	Technosphere	
	Input	Refined resource	TAED	0.0171			kg	Technosphere	
	Input	Refined resource	Water	1.27			kg	Technosphere	
	Input	Refined resource	Zeolite A	0.256			kg	Technosphere	
	Input	Resource	Bauxite	0.0249			kg	Ground	
	Input	Resource	Biomass	0.412			kg	Ground	
	Input	Resource	Crude oil	7.7			kg	Ground	
	Input	Resource	Hard coal	3.33			kg	Ground	
	Input	Resource	Hydro energy	81.9			kg	Ground	
	Input	Resource	Iron in ore	0.018			kg	Ground	
	Input	Resource	Iron ore	0.00109			kg	Ground	
	Input	Resource	Lignite	1.16			kg	Ground	
	Input	Resource	Limestone	0.133			kg	Ground	
	Input	Resource	Natural gas	2.8			kg	Ground	
	Input	Resource	Sodium chloride	0.0256			kg	Ground	
	Input	Resource	Unspecified fuel	0.00000728			MJ	Ground	
	Input	Resource	Water	85.1			kg	Ground	

Notes: Unspecified type of water.	Input	Resource	Water	979			kg	Water	
	Input	Resource	Wind energy	0.17			MJ	Ground	
	Input	Resource	Wood	0.633			kg	Ground	
	Output	Emission	BOD	0.00392			kg	Water	
	Output	Emission	Cl-	0.0519			kg	Water	
	Output	Emission	CO	0.139			kg	Air	
	Output	Emission	CO2	41.6			kg	Air	
	Output	Emission	COD	0.0437			kg	Water	
	Output	Emission	Dissolved organics	0.0475			kg	Water	
	Output	Emission	Dissolved solids	0.00101			kg	Water	
	Output	Emission	H2	0.00112			kg	Air	
	Output	Emission	HCl	0.00242			kg	Air	
	Output	Emission	Methane	0.0794			kg	Air	
	Output	Emission	N total	0.00159			kg	Water	
	Output	Emission	NMVOC	0.0863			kg	Air	
	Output	Emission	NMVOC, oil combustion	0.00242			kg	Air	
	Output	Emission	NOx	0.138			kg	Air	
	Output	Emission	Oil	0.0015			kg	Water	
	Output	Emission	Other organics	0.00161			kg	Water	
	Output	Emission	Other organics	0.0432			kg	Air	
	Output	Emission	P Total	0.00107			kg	Water	
Notes: discharges to soil via sludge	Output	Emission	P Total	0.00742			kg	Ground	
	Output	Emission	Particles	0.0526			kg	Air	
	Output	Emission	SO42-	0.00663			kg	Water	
	Output	Emission	Sodium chloride	0.00169			kg	Water	
	Output	Emission	SOx	0.214			kg	Air	
	Output	Emission	Suspended solids	0.00458			kg	Water	
	Output	Residue	Bulky	0.19			kg	Technosphere	
	Output	Residue	Cardboard	0.251			kg	Technosphere	
Notes: Non-elementary water discharges (substances not covered in data for wastewater treatment plant)	Output	Residue	Cl-	0.0126			kg	Technosphere	
	Output	Residue	Edge strips	0.126			kg	Technosphere	
	Output	Residue	Fabrics	0.19			kg	Technosphere	
Notes: Hazardous output	Output	Residue	Hazardous waste	0.322			kg	Technosphere	
	Output	Residue	Highly radioactive	0.001			kg	Technosphere	
	Output	Residue	Lubricant oil	0.00000464			kg	Technosphere	
Notes: unspecified metals	Output	Residue	Metals	0.0151			kg	Technosphere	
	Output	Residue	Mineral waste	0.00515			kg	Technosphere	
	Output	Residue	Minerals	0.561			kg	Technosphere	
Notes: Industrial waste	Output	Residue	Mixed industrial waste	0.00144			kg	Technosphere	
Notes: Industrial output	Output	Residue	Mixed industrial waste	2.44			kg	Technosphere	
	Output	Residue	Non-toxic chemicals	0.00284			kg	Technosphere	
	Output	Residue	Other	2.42			kg	Technosphere	
	Output	Residue	Paper	0.017			kg	Technosphere	
	Output	Residue	Polyethylene	0.09			kg	Technosphere	
	Output	Residue	Polypropylene	0.363			kg	Technosphere	
	Output	Residue	Regulated chemicals	0.00225			kg	Technosphere	
Notes: Elementary waste via non-elementary outputs.	Output	Residue	Slag	0.168			kg	Technosphere	
Notes: Ashes	Output	Residue	Slag/Ashes	0.00183			kg	Technosphere	
	Output	Residue	Slags and ash	0.00103			kg	Technosphere	
Notes: from energy production	Output	Residue	Slags and ash	0.0438			kg	Technosphere	
Notes: Elementary waste via non-elementary outputs.	Output	Residue	Sludge	0.382			kg	Technosphere	
	Output	Residue	Spillage	0.0126			kg	Technosphere	
Notes: Yarn.	Output	Residue	Spillage	0.216			kg	Technosphere	
Notes: With packaging.	Output	Residue	Textile sample	0.229			kg	Technosphere	

Notes: Non-elementary water discharges (substances not covered in data for wastewater treatment plant)	Output	Residue	Total organic carbon	0.0769			kg	Technosphere	
	Output	Residue	Wood	0.63			kg	Technosphere	

About Inventory	
Publication	Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector - a case study concerning fabrics for a sofa. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2004-7.pdf
Intended User	LCA and textile practitioner
General Purpose	Part of doctoral studies. ''The overall purpose of the studies is to give suggestions for solving some of the methodological issues within the LCA method when used in the field of textiles.''
Detailed Purpose	''The goal of this case study was to identify, map and discuss LCA methodological issues in the textile sector. This was done by carrying out an LCA study with the goal of ranking three fabric types for a sofa. i) The main reason for carrying out the study was that the LCA methodology is not fully developed and different sectors have different method development needs. This work was being done on the basis of interest from the textile industry in Sweden. ii) The study could be used for further development regarding methodological issues in the efforts to establish Product Specific Rules (PSRs) for Certified Environmental Declarations (EPDs) in the textile sector (the Swedish Environmental Management Council 2000) and for the modification work of the ISO 14040 (1997) - ISO 14043 (2000) standards. iii) It is intended to be used by purchasers, designers, etc., in the textile industry as well as for researchers and others working with the ISO 14040 (1997) - ISO 14043 (2000) standards.''
Commissioner	Stiftelsen Svensk Textilforskning - .
Practitioner	Lisbeth Dahllöf - .
Reviewer	Maria Walenius Henriksson - IFP Research AB
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Importer of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The original publication includes more information about data. ''The studies are being carried out at the Environmental Systems Analysis Department at Chalmers University of Technology in Gothenburg, Sweden and are being financed mainly by Stiftelsen Svensk Textilforskning and CPM, Centre for Environmental Assessment of Product and Material Systems.''

SPINE LCI dataset: Flexible PUR foam

Administrative	
Finished	Y
Date Completed	1996
Copyright	
Availability	

Technical System

Name	Flexible PUR foam
Functional Unit	1 kg of flexible PUR foam
Functional Unit Explanation	
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	This set of data does not concern the production of the polyurethane precursors (TDI, MDI, Polyols) but the production of one particular type of polyurethane foam. In fact, polyurethane foam can be rigid, flexible, etc. and then one can find different recipies for it (different mixing of the precursors). In fact, here is the recipe of the FLEXIBLE POLYURETHANE FOAM.

System Boundaries

Nature Boundary	Air-, water emissions and wastes going out of our system Resource arriving into our system
Time Boundary	
Geographical Boundary	Europe
Other Boundaries	
Allocations	Unspecified
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	98/01/26
Data Type	Unspecified
Represents	See 'Function'.
Method	Normal LCI method for the produciton of flexible PUR foam (from the cradle to the gate)
Literature Reference	Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector - a case study concerning fabrics for a sofa. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2004-7.pdf
Notes	This data set is generated with the software LCAit. All values that are below 0.001 kg and values given in the unit Bq are excluded. These values can be found in the litterature reference.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity	1.5			MJ	Technosphere	Europe
	Input	Refined resource	Polyether - polyols	0.713			kg	Technosphere	Europe
	Input	Refined resource	TDI	0.285			kg	Technosphere	Europe
	Input	Refined resource	Water	0.021			kg	Technosphere	Europe
	Output	Emission	CO2	0.051			kg	Air	Europe
	Output	Product	Flexible	1			kg	Technosphere	Europe
Notes: Waste foam (APME report)	Output	Residue	Other rest products	0.02			kg	Technosphere	Europe

About Inventory

Publication	Eco profiles ot the European plastics industry Report 9 : Polyurethane precursors (TDI, MDI, Polyols) APME technical report June 1996 -- Data documented by: Sophie Louis, Volvo Technical Development

	Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	APME's eco-profiles serve two
General Purpose	There is an increasing demand concerning LCA data. Following this trend, ISOPA [The European Isocyanate Producers Association] members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of flexible PUR foam
Commissioner	- ISOPA, Avenue E. van Nieuwenhuyse 4 Box 2 B 1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	
About Data	The transport of the different precursors is not included and must be added to the final inventory, depending on which distance is driven. Data on the production processes have been supplied by ARCO Chemical, BASF, BAYER, DOW, Enichem, ICI, Rhone Poulenc and Shell relating to plants operating in Belgium, France Germany, Italy, the Netherlands, Portugal, Spain and the United Kingdom.
Notes	

SPINE LCI dataset: Floor maintenance. ESA-DBP

Administrative	
Finished	Y
Date Completed	1999
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Floor maintenance. ESA-DBP
Functional Unit	1 m2 * year
Functional Unit Explanation	Excerpt from the report (see 'Publication'): ''For the LCI one square meter, one year and once a week were the parameters used to evaluate the linoleum maintenance impact.''
Process Type	Gate to gate
Site	Not applicable
Sector	Activities of households as employers
Owner	Not applicable
Technical system description	Floor maintenance is assumed to be done manually with a mop and the swedish cleaning product ''All rent''. This process is included in the system described in: Blanco-Rosete S. R., 2002, LCA data structure and time series related to construction and maintenance in Sweden. Environmental Systems Analysis report 2002:14, Chalmers University of Technology, Gothenburg, Sweden Other processes in the CPM Database also included in the above publication: Swedish red paint manufacturing and application. ESA-DBP Clay roof tile manufacturing. ESA-DBP Exterior coating (Swedish red paint) maintenance. ESA-DBP Pine window production. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report (see 'Publication'): ''Emissions considered production of ''All rent'', mop and floor maintenance.''
Time Boundary	1999
Geographical Boundary	Sweden
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1999
Data Type	Unspecified
Represents	See 'Function'.
Method	Unknown.
Literature Reference	Paulsen J, 1999, LCA på golvmaterial - fallstudier med särskild hänsyn till användningsfasen. Kungliga Tekniska Högskolan, Stockholm, Sweden
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Chemicals	1.24E-06			m3	Technosphere	
	Input	Refined resource	Fossil fuel	0.0728			MJ	Technosphere	
	Input	Refined resource	Lime	1.03E-05			kg	Technosphere	
	Input	Refined resource	Oxygen	0.000121			kg	Technosphere	
	Input	Refined resource	Soap	1.24E-06			m3	Technosphere	
	Input	Refined resource	Sulphuric acid	1.73E-05			kg	Technosphere	
	Input	Resource	Bentonite	1.07E-06			kg	Ground	
	Input	Resource	Biomass	0.001942			kg	Ground	
	Input	Resource	Copper in ore	1.54E-06			kg	Ground	
	Input	Resource	Crude oil	0.001669			kg	Ground	
	Input	Resource	Hard coal	0.001862			kg	Ground	
	Input	Resource	Hydro power	0.3776			MJ	Ground	
	Input	Resource	Iron in ore	7.62E.06			kg	Ground	
	Input	Resource	Lead in ore	2.74E-08			kg	Ground	
	Input	Resource	Lignite	1.48E-05			kg	Ground	
	Input	Resource	Natural gas	0.000167			kg	Ground	
	Input	Resource	Uranium in ore	2.87e-06			kg	Ground	
	Input	Resource	Wind power	0.000803			MJ	Ground	
	Output	Emission	CO	4.04E-06			kg	Air	
	Output	Emission	CO2	0.002048			kg	Air	
	Output	Emission	CO2	0.01622			kg	Air	
	Output	Emission	COD	5.20E-06			kg	Water	
	Output	Emission	Dissolved solids	1.09E-06			kg	Water	
	Output	Emission	Dust	5.20E-06			kg	Air	
	Output	Emission	Hydrocarbons	6.24E-05			kg	Air	
	Output	Emission	Methane	1.38E-05			kg	Air	
	Output	Emission	N2O	1.53E-08			kg	Air	
	Output	Emission	NH3	1.24E-10			kg	Air	
	Output	Emission	NH3	5.20E-11			kg	Water	
	Output	Emission	NOx	3.74E-05			kg	Air	
	Output	Emission	N-tot	1.12E-07			kg	Water	
	Output	Emission	Oil	2.61E-09			kg	Water	
	Output	Emission	PAH	7.64E-14			kg	Air	

	Output	Emission	Particles	2.27E-06			kg	Air	
	Output	Emission	Rn-222	10700			Bq	Air	
	Output	Emission	SO2	2.63E-05			kg	Air	
	Output	Emission	VOC	3.00E-06			kg	Air	
	Output	Product	Floor maintenance	1			m2 year	Technosphere	
	Output	Residue	Ashes	0.000175			kg	Technosphere	
Notes: Demolition waste	Output	Residue	Demolition waste	7.22E-06			kg	Technosphere	
	Output	Residue	Highly radioactive waste	4.71E-06			kg	Technosphere	
	Output	Residue	Industrial waste	0.000104			kg	Technosphere	
	Output	Residue	Other	0.0114			kg	Technosphere	

About Inventory

Publication	Blanco-Rosete S. R., 2002, LCA data structure and time series related to construction and maintenance in Sweden. Environmental Systems Analysis report 2002:14, Chalmers University of Technology, Gothenburg, Sweden
Intended User	LCA practitioners.
General Purpose	This process data set is recalculated to fit in the Master Thesis given in 'Publication'. Excerpt from the report (see 'Publication'): ''Construction, building maintenance and housing management contribute to a large extent to the environmental impact. When housing owners and managers perform their activities they should be aware of the environmental effects they cause. The environmental impact of existing houses could be addressed and diminished within the possibilities of a clever management.''
Detailed Purpose	Excerpt from the report (see 'Publication'): ''This master thesis descibes and defines a building system model for a multi-family house in Gothenburg over a 30 year period from 1970 to 2002 . The model was used to collect environmental impact information regarding materials or products used in the construction and maintenance of a building . The environmental impact ofa a multi-family house was evaluated through a Life Cycle Assessment (LCA). Finally to account the long sevice lifetime of a multi-family house two case studies were carried out to test if the use of Time series can illustrate the environmental impact of maintenance activities caused by decisionmaking in housing management.''
Commissioner	Not applicable - .
Practitioner	Sergio R. Blanco-Rosete - .
Reviewer	Birgit Brunklaus - Environmental Systems Analysis
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpt from the report (see 'Publication'): ''Data for the maintenance of linoleum is taken from one of the described scenarios in ''Life cycle assessment for building products. The significance of the usage phase.'' (Paulsen ,1999). In that study tables for emissions are presented as factors in order to estimate the impact produced according to the area, time and frequency the maintenance is taking place.'' ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-09-21 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Forging of ingot into steel bars, 350 mm

Administrative

Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Forging of ingot into steel bars, 350 mm
Functional Unit	One ton of forged steel bars, 350 mm
Functional Unit Explanation	The forged steel bars will serve as raw material for the ring production at the ring mill at Ovako Steel AB in Hofors. The rings will later be processed into bearing rings at SKFs site in Göteborg and finally mounted into the SKF spherical roller bearing 232/530.
Process Type	Gate to gate
Site	Scana Steel Söderfors ABBox 104 815 04 SÖDERFORS
Sector	Materials and components
Owner	Scana Steel Söderfors ABBox 104 815 04 SÖDERFORS
Technical system description	This activity is a process step in the system ''Production of bearing rings'', this activity is available in the SPINE@CPM database. When producing the bearing rings the heated steel ingot needs to be forged into steel bars. This dataset represents environmental impact from this activity. The ingot is cold when the process starts at the forge at Scana Steel AB in Söderfors. As a first step the ingot is heated in an oven. The first part of the oven heats the ingot from room temperature to 180°C immediately. The ingot is then transported through different temperature areas and is slowly heated until it reaches 1150°C. This heating process takes approximately 1-2 days. The next process step is pressing in the forging press. The heated ingot is put in the press and edged into round shape. Finally the now nearly round bars are pressed complete round while rotating against a round swage in form of two half circles. The forging is completed and the forged bars are inspected and cooled in room temperature for approximately one day.

System Boundaries	
Nature Boundary	Emissions to water are not known. Emissions to air are included. The emissions to air refer mostly to the combustion of the heavy fuel oil, taking place in the forge oven.
Time Boundary	All data refers to year 2001. No changes are planned for the nearest future.
Geographical Boundary	The forging mill is located at Scana Steel Söderfors AB in Söderfors, Sweden.
Other Boundaries	No internal transport is included. The production of heavy fuel oil and electricity is NOT included in this dataset, but must be followed from the grave to obtain the total environmental impact.
Allocations	Allocation have been made according to weight.
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'.
Method	The data has been gathered from interviews with Leif Hedström at Scana Steel Söderfors AB in Söderfors. He picked data from Scana´s environmental report from year 2001. Some data has been estimated by Leif Hedström. According to Leif, 15017 ton forged material was produced during year 2001. This is approximately 2/3 of all material totally produced at Scana Steel AB in Söderfors 2001. 2/3 of the emissions and the electricity and oil consumption in the environmental report for year 2001, was allocated to the forged material. Consumption of grease and lubricating oil is allocated to the forged material 100%, according to Leif Hedström.

Literature Reference	Paulsen J, 1999, LCA på golvmaterial - fallstudier med särskild hänsyn till användningsfasen. Kungliga Tekniska Högskolan, Stockholm, Sweden
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity	81.8			kWh	Technosphere	Sweden
	Input	Refined resource	Grease	0.0666			kg	Technosphere	Sweden
	Input	Refined resource	Heavy fuel oil	3388			MJ	Technosphere	Sweden
	Input	Refined resource	Hydraulic Oil	0.3995			l	Technosphere	Sweden
Date concieved: 02-08-01 - 02-12-31 Data type: Unspecified, guesstimate Method: The data is estimated by Leif Hedström at Scana Steel Söderfors AB.	Input	Refined resource	Ingot Mould	1015.2			kg	Technosphere	Sweden
	Input	Refined resource	Lubricating Oil	0.133			l	Technosphere	Sweden
	Output	Emission	CO2	0.36			kg	Air	Sweden
	Output	Emission	NOx	1.25			kg	Air	Sweden
	Output	Emission	Sulphur	0.35			kg	Air	Sweden
	Output	Product	Forged Bars	1000			kg	Technosphere	Sweden
	Output	Residue	Particles	0.023			kg	Technosphere	Sweden
	Output	Residue	Steel scrap	15.2			kg	Technosphere	Sweden

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The dataset is applicable to the forging of ingot into steelbars, 350 mm, at the forging mill at Scana Steel Söderfors AB in Söderfors, Sweden.
About Data	Data is gathered from interviews with Leif Heström at Scana Steel Söderfors AB in Söderfors, Sweden. The data is obtained from Scana Steel´s environmental report 2001.
Notes	

SPINE LCI dataset: Forwarding of harvested wood

Administrative

Finished	Y

Date Completed	1998-02-13
Copyright	None
Availability	Public

Technical System

Name	Forwarding of harvested wood
Functional Unit	m3sub
Functional Unit Explanation	Per m3sub softwood transported from the felling site to the roadside.
Process Type	Gate to gate
Site	Middle Sweden
Sector	Forestry
Owner	Middle Sweden
Technical system description	Forwarding is the transport of any felled wood (from thinning or final felling) from the felling area to the road side. This activity is succeded by a transport of the wood to a sawmill or a pulp mill. These transports vary from case to case and are therfore not included in this line of operations.

System Boundaries

Nature Boundary	Emissions caused by combustion of fuels is not included.
Time Boundary	The data collected are representative for the time period 1992-1994.
Geographical Boundary	Central Sweden
Other Boundaries	N/A
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1994-02-24
Data Type	Unspecified, expert outspoke
Represents	See 'Function'.
Method	See under each specific QMetaData
Literature Reference	Paulsen J, 1999, LCA på golvmaterial - fallstudier med särskild hänsyn till användningsfasen. Kungliga Tekniska Högskolan, Stockholm, Sweden
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: 100 of the total 400 m3sub/ha wood that is taken out from forestry is taken out during Thinning. (or 25%)	Input	Product	Thinning softwood	0.25			m3 fub	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: 1,2 l diesel per m3sub (plus 6% extra) with the energy contents of 35,6 MJ/l is used, leaving 45,3 MJ diesel/m3sub.	Input	Refined resource	Diesel	45.3			MJ	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: 300 of the total 400	Input	Refined resource	Final felling softwood	0.75			m3 fub	Technosphere	Sweden

m3sub/ha wood that is taken out from forestry is taken out during Final felling. (or 75%)									
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke	Output	Product	Softwood at roadside	1			m3 fub	Technosphere	Sweden

About Inventory	
Publication	Nne -- Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose is to supply with LCA-data for forestry to be used in further studies of wood products.
Detailed Purpose	These data are an update of earlier data on the same subject. To be used in LCA representing the forwarding part of forestry in central Sweden. Can also be used as an average for Sweden.
Commissioner	- Stora Corporate Research, Box 601 661 29 Säffle Sweden.
Practitioner	Swan, Göran - Stora Corporate Research, Box 601, S-661 29 Säffle, Sweden.
Reviewer	
Applicability	These data are valid for large scale forwarding in forestry. It is important to check the type of fuel used. In this case, fossil fuel is assumed to be used. Other data is available from other forest companies, or from Skogforsk, or STFI. The silviculture process in Sweden has eight steps: 1. Plant nursing 2. Soil preparation 3. Planting 4. Clearing 5. Thinning 6. Fertilizing 7. Final felling 8. Forwarding This is the eighth step.
About Data	N/A
Notes	

SPINE LCI dataset: Fossil diesel - EN590 combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Fossil diesel - EN590 combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of fossil diesel EN590 to vehicle tank

Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from fossil diesel - EN590 combustion in heavy duty truck or bus, Euro V, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'.
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on ETC (transient test cycle for truck and bus engines), legislation limits for Euro V (2005/55/EC). The ETC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.44 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.
Literature Reference	Main references: (1) 2005/55/EC (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) SPBI (http://spbi.se/blog/faktadatabas/artiklar/berakningsmodeller/) (5) Dir 2009/30/EC
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Product	Diesel EN590	1			MJ	Technosphere	
Method: The SPBI web site publishes the CO2 emission per liter fuel (2.66 kg CO2/l) and a density of 0.840 kg/l and a heat value of 35.8 MJ/l. This corresponds to a heat value per kg of 42.6 MJ/kg and to a carbon content of 86.4 w-%. Recalculating to per MJ of	Output	Emission	Carbon dioxide (fossil)	0.0743			kg	Air	

fuel, 0.0743 kg of fossil CO2 per MJ is obtained (1 kg of C generates 3.67 kg of CO2). Literature: SPBI									
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Carbon monoxide	4.88888888888889E-04			kg	Air	
Method: 10% of THC according to JRC (2013). Literature: JRC (2013)	Output	Emission	Methane	6.72222222222222E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Nitrogen oxides	2.44444444444444E-04			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	6.11111111111111E-06			kg	Air	
Method: THC minus CH4. Literature: THC is from limit in Euro V legislation	Output	Emission	Non-methane volatile organic compounds	0.0000605			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Particles (unspecified)	3.66666666666667E-06			kg	Air	
Method: The legislative limit is 10 mg/kg (10 ppm) (Dir 2009/30/EC), but here a typical value for Europe is chosen. 1 kg of S generates 2 kg of SO2. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 42.6 MJ/kg. Literature: Typical value	Output	Emission	Sulfur dioxide	2.8169014084507E-07			kg	Air	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Fossil diesel - EN590 combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Fossil diesel - EN590 combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of fossil diesel EN590 to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions fromfossil fuel - EN590 combustion in heavy duty truck or bus, Euro VI, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	See 'Function'.

Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on WHTC (World Harmonized Transient Cycle for truck and bus engines), legislation limits for Euro VI (Commission Regulation (EC) No 582/2011).The WHTC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.44 (?)=(energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.
Literature Reference	Main references: (1) Commission Regulation (EC) No 582/2011 (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and powertrains in the European context, July 2013 (4) SPBI (http://spbi.se/blog/faktadatabas/artiklar/berakningsmodeller/) (5) Dir 2009/30/EC
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Product	Diesel EN590	1			MJ	Technosphere	
Method: The SPBI web site publishes the CO2 emission per liter fuel (2.66 kg CO2/l) and a density of 0.840 kg/l and a heat value of 35.8 MJ/l. This corresponds to a heat value per kg of 42.6 MJ/kg and to a carbon content of 86.4 w-%. Recalculating to per MJ of fuel, 0.0743 kg of fossil CO2 per MJ is obtained (1 kg of C generates 3.67 kg of CO2). Literature: SPBI	Output	Emission	Carbon dioxide (fossil)	0.0743			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Carbon monoxide	4.88888888888889E-04			kg	Air	
Method: 10% of THC according to JRC (2013). Literature: JRC (2013)	Output	Emission	Methane	1.95555555555556E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Nitrogen oxides	5.62222222222222E-05			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	6.11111111111111E-06			kg	Air	
Method: THC minus CH4. Literature: THC is from limit in Euro VI legislation	Output	Emission	Non-methane volatile organic compounds	0.0000176			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Particles (unspecified)	1.22222222222222E-06			kg	Air	
Method: The legislative limit is 10 mg/kg (10 ppm) (Dir 2009/30/EC), but here a typical value	Output	Emission	Sulfur dioxide	2.8169014084507E-07			kg	Air	

for Europe is chosen. 1 kg of S generates 2 kg of SO2. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 42.6 MJ/kg. Literature: Typical value										

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Fossil diesel - MK1 combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Fossil diesel - MK1 combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of fossil diesel MK1 to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from fossil diesel - MK1 combustion in heavy duty truck or bus, Euro V, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the

	certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'.
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on ETC (transient test cycle for truck and bus engines), legislation limits for Euro V (2005/55/EC). The ETC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.44 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.
Literature Reference	Main references: (1) 2005/55/EC (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) SPBI (http://spbi.se/blog/faktadatabas/artiklar/berakningsmodeller/) (5) Dir 2009/30/EC
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Product	Diesel MK1	1			MJ	Technosphere	
Method: The SPBI web site publishes the CO2 emission per liter fuel (2.54 kg CO2/l) and a density of 0.815 kg/l and a heat value of 35.8 MJ/l. This corresponds to a heat value per kg of 43.3 MJ/kg and to a carbon content of 85.0 w-%. Recalculating to per MJ of fuel, 0.0720 kg of fossil CO2 per MJ is obtained (1 kg of C generates 3.67 kg of CO2). Literature: SPBI	Output	Emission	Carbon dioxide (fossil)	7.19954648526077E-02			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Carbon monoxide	4.88888888888889E-04			kg	Air	
Method: 10% of THC according to JRC (2013). Literature: JRC (2013)	Output	Emission	Methane	6.72222222222222E-06			kg	Air	

Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Nitrogen oxides	2.44444444444444E-04			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	6.11111111111111E-06			kg	Air	
Method: THC minus CH4. Literature: THC is from limit in Euro V legislation	Output	Emission	Non-methane volatile organic compounds	0.0000605			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Particles (unspecified)	3.66666666666667E-06			kg	Air	
Method: The legislative limit is 10 mg/kg (10 ppm) (Dir 2009/30/EC), but here a typical value is chosen. 1 kg of S generates 2 kg of SO2. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 43.3 MJ/kg. Literature: Typical value	Output	Emission	Sulfur dioxide	1.38568129330254E-07			kg	Air	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Fossil diesel - MK1 combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels

Administrative	
Finished	Y

Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Fossil diesel - MK1 combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of fossil diesel MK1 to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from fossil diesel - MK1 combustion in heavy duty truck or bus, Euro VI, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	See 'Function'.
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on WHTC (World Harmonized Transient Cycle for truck and bus engines), legislation limits for Euro VI (Commission Regulation (EC) No 582/2011).The WHTC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.44 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.
Literature Reference	Main references: (1) Commission Regulation (EC) No 582/2011 (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) SPBI (http://spbi.se/blog/faktadatabas/artiklar/berakningsmodeller/) (5) Dir 2009/30/EC

Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Product	Diesel MK1	1			MJ	Technosphere	
Method: The SPBI web site publishes the CO2 emission per liter fuel (2.54 kg CO2/l) and a density of 0.815 kg/l and a heat value of 35.8 MJ/l. This corresponds to a heat value per kg of 43.3 MJ/kg and to a carbon content of 85.0 w-%. Recalculating to per MJ of fuel, 0.0720 kg of fossil CO2 per MJ is obtained (1 kg of C generates 3.67 kg of CO2). Literature: SPBI	Output	Emission	Carbon dioxide (fossil)	7.19954648526077E-02			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Carbon monoxide	4.88888888888889E-04			kg	Air	
Method: 10% of THC according to JRC (2013). Literature: JRC (2013)	Output	Emission	Methane	1.95555555555556E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Nitrogen oxides	5.62222222222222E-05			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	6.11111111111111E-06			kg	Air	
Method: THC minus CH4. Literature: THC is from limit in Euro VI legislation	Output	Emission	Non-methane volatile organic compounds	0.0000176			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Particles (unspecified)	1.22222222222222E-06			kg	Air	
Method: The legislative limit is 10 mg/kg (10 ppm) (Dir 2009/30/EC), but here a typical value is chosen. 1 kg of S generates 2 kg of SO2. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 43.3 MJ/kg. Literature: Typical value	Output	Emission	Sulfur dioxide	1.38568129330254E-07			kg	Air	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner

General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: France, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	France, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	France
Sector	Energyware
Owner	France
Technical system description	The generation of electricity with different power generating systems in France during the year 1998. France includes Monaco, and excludes overseas departments (Matinique, Guadeloupe, French Polynesia and Réunion).

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	11651			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	1762			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	2308			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	35550			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	36			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	387990			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	4975			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	590			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	62070			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	506932			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version

	- Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Freight plane, MD-82

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Freight plane, MD-82
Functional Unit	1 tonkm, 300 km, 65%
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 km calculated for 300 km flight distance and an average utilisation level equivalent to 65 % passenger occupation (9 450 kg)
Process Type	Unit operation
Site	Sweden

Sector	Air transport
Owner	Sweden
Technical system description	Operation of MD-82 aircraft, only carrying cargo. The operation includes take-off, climb, cruise, descent and landing (including operations on the ground). *Technical data for the aircraft:* Maximum take-off weight 67,8 tonnes. Maximum payload (i.e. maximum loading capacity with regard to weight) 17100 tonnes. Max cruising altitude 11,300 metres Cruising speed 815-825 km/h Length: 45.1 m Wing span: 32.9 m Range: 3,200 km Engine: P&W JT8D-217C/-219

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents aircraft in use in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The data is only valid for a flight distance of 300 km, and an average utilisation equivalent to 65 % passenger occupation (9 450 kg). The maximum value is equivalent to 49 % (6 450 kg) and the minimum value is equivalent to 86 % passenger occupation (12 450 kg). *Parameters not considered* -External conditions i.e. climate etc -Maintenance level of the aircraft. *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel -Maintenance of the aircraft -After-treatment of the aircraft -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Modeled data
Represents	See 'Function'.
Method	The energy use and emissions per tonkm was obtained by simulation calculations performed by FFA (The Aeronautical Research Institute of Sweden) for a flight distance of 300 km. The *quantity value* is equivalent to a passenger occupation of 65% (9450 kg), the *minimum value* corresponds to a passenger occupation of 81 % (12450 kg) and the *maximum value* of 49 % (6450 kg). The simulation calculations is performed in two steps. To obtain the fuel consumption, the flight path for each section is simulated, where both load and flight distance is accounted for. The position of the aircraft and the operation conditions of the engine are established for every second of the flight. This data is used in a new simulation where the exhaust emissions are calculated with regard to engine speed and flying altitude for every moment of the flight. The result from the simulation is then used to calculate the energy use and emissions per tonkm. The data include landing and take off, i.e. flight operations below 3000 feet (including operation of the ground) *Data used for the fuel:* -Thermal value: 43,2 MJ/kg -Sulphur content: 500 ppm
Literature Reference	Larsson, Lars Gunnar, Calculations performed at FFA for NGM, 1997, Not published
Notes	The data is only valid for a flight distance of 300 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Kerosene	28	22	35	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	3.4	2.6	4.2	g	Air	Sweden
	Output	Emission	CO2	2090	1630	2560	g	Air	Sweden
	Output	Emission	HC	0.65	0.49	0.81	g	Air	Sweden
	Output	Emission	NOx	10.5	8.46	12.45	g	Air	Sweden
	Output	Emission	SO2	0.66	0.51	0.81	g	Air	Sweden

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Larson, Lars-Gunnar - FFA (Flygtekniska försöksanstalten), Box 11021 S-161 11 Bromma Sweden.
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the plane, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Goods transportation by air transport is done either in special freight planes or in regular passenger flights together with passengers. Air transport is primarily used for transportation of valuable or fragile goods and for speedy deliveries. Air transport is also more expensive than other modes of transportation. Consequently, very little goods are transported by aircraft. The major part of the goods is transported in regular passenger planes. The amount of goods that can be carried in passenger aircraft is however small. The average load of goods in a passenger aircraft is below 100 kg and is equivalent to an average passenger with average luggage. The passenger occupation will therefore have a large influence on the energy use and the emissions for goods carried in regular passenger aircraft. The MD-82 was chosen to represent Swedish air transport since it is one of the most common used aircraft in domestic regular traffic in Sweden. The aircraft represents an average regarding both technical standard and emissions. The aircraft has a long average lifetime. ***Utilisation level and distance*** For air transports, data on energy use and emissions per tonkm may only be given for a specific flight distance since the energy use and emissions vary substantially during the

	different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights longer than 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance. Consequently, the longer the flight the more energy efficient transport. Aircraft are optimised for energy efficiency during the cruise phase. The average distance for Swedish domestic flights is between 300 and 600 km. Data for freight planes was therefore both given for a flight distance of 300 km and 600 km. The average utilisation was assumed to be equivalent to a passenger occupation of 65 %, which may be a conservative assumption compared to actual operation. To obtain a minimum and a maximum value for the energy use and emissions, data was also given for a higher utilisation (81 %, the minimum value in the data) and a lower utilisation (49 %, the maximum value). To calculate energy use and emissions for other flight distances, the following relations may be used, where x=total distance in km. These relations are valid for flights longer than 300 km and concern a MD-82 loaded with 9450 kg i.e. a utilisation level equivalent to a passenger occupation of 65%. -Kerosene: 2220 + 3,1*(x-300) [kg] -CO2: 7015 + 9,8*(x-300) [kg] -CO: 9,6 + 0,0129*(x-300) [kg] -HC: 1,848 + 0,0049*(x-300) [kg] -NOx: 29,85 + 0,031*(x-300) [kg] -SO2: 2,22 + 0,003*(x-300) [kg]
About Data	The data is based on simulation calculations performed at FFA (The Aeronautical Research Institute of Sweden).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Freight plane, MD-82

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Freight plane, MD-82
Functional Unit	1 tonkm, 600 km, 65%
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for a flight distance of 600 km and an average utilsation level equivalent to 65 % passenger occupation (9 450 kg). .
Process Type	Unit operation

Site	Sweden
Sector	Air transport
Owner	Sweden
Technical system description	Operation of MD-82 aircraft, only carrying cargo. The operation includes take-off, climb, cruise, descent and landing (including operations on the ground). *Technical data for the aircraft:* Maximum take-off weight 67,8 tonnes. Maximum payload (i.e. maximum loading capacity with regard to weight) 17100 tonnes. Max cruising altitude 11,300 metres Cruising speed 815-825 km/h Length: 45.1 m Wing span: 32.9 m Range: 3,200 km Engine: P&W JT8D-217C/-219

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental impacts have not been considered.
Time Boundary	The data represents aircraft in use in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The flight distance is 600 km. The quantity value is equivalent to 65 % passenger occupation (9 450 kg). The maximum value is equivalent to 49 % (6 450 kg) and the minimum value is equivalent to 86 % passenger occupation (12 450 kg). *Parameters not considered* External conditions i.e. climate etc Maintenance level of the aircraft. *Excluded subsystems* Precombustion, i.e. production and distribution of the fuel Maintenance of the aircraft After-treatment of the aircraft Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1997-01-01
Data Type	Modeled data
Represents	See 'Function'.
Method	The energy use and emissions per tonkm was obtained by simulation calculations performed by FFA (The Aeronautical Research Institute of Sweden) for a flight distance of 600 km. The *quantity value* is equivalent to a passenger occupation of 65% (9450 kg), the *minimum value* corresponds to a passenger occupation of 81 % (12450 kg) and the *maximum value* of 49 % (6450 kg). The simulation calculations is performed in two steps. To obtain the fuel consumption, the flight path for each section is simulated, where both load and flight distance is accounted for. The position of the aircraft and the operation conditions of the engine are established for every second of the flight. This data is used in a new simulation where the exhaust emissions are calculated with regard to engine speed and flying altitude for every moment of the flight. The result from the simulation is then used to calculate the energy use and emissions per tonkm. The data include landing and take off, i.e. flight operations below 3000 feet (including operation of the ground) *Data used for the fuel:* -Thermal value: 43,2 MJ/kg -Sulphur content: 500 ppm
Literature Reference	Lars-Gunnar Larson, Calculations performed at FFA (Flygtekniska försöksanstalten) for NGM, 1997, Not published
Notes	The data is only valid for a flight distance of 600 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight

	distance.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Kerosene	21	17	26	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	2.4	1.8	3	g	Air	Sweden
	Output	Emission	CO2	1580	1230	1920	g	Air	Sweden
	Output	Emission	HC	0.59	0.45	0.73	g	Air	Sweden
	Output	Emission	NOx	7	5.67	8.33	g	Air	Sweden
	Output	Emission	SO2	0.5	0.39	0.6	g	Air	Sweden

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Larson, Lars-Gunnar - FFA (Flygtekniska försöksanstalten), Box 11021 S-161 11 Bromma Sweden.
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the plane, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Air transport is done either in special freight planes or in regular passenger flights together with passengers. Air transport is primarily used for transportation of valuable or fragile goods and for speedy deliveries and is also more expensive than other modes of transportation. Consequently, very little goods are transported by aircraft. The share of goods transported by special freight planes is low compared to the goods transported on regular passenger flights. The amount of goods that can be carried in passenger aircraft is however small. The average load of goods in a passenger aircraft is below 100 kg and is equivalent to an average passenger with average luggage. The passenger occupation will therefore have a large influence on the energy use and the emissions for goods carried in regular passenger aircraft. The MD-82 was chosen to represent Swedish air transport since it is one of the most common used aircraft in domestic regular traffic in Sweden. The aircraft represents an average regarding both technical standard and emissions. The aircraft has a long average lifetime.

	Utilisation level and distance For air transports, data on energy use and emissions per tonkm may only be given for a specific flight distance since the energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance. Consequently, the longer the flight the more energy efficient transport. Aircraft are optimised for energy efficiency during the cruise phase. The average distance for Swedish domestic flights is 300 - 600 km. Data for freight planes was therefore given for a flight distance of 300 km and 600 km. The average utilisation level was assumed to be 65 %, which may be a conservative assumption compared to actual operation. To obtain a minimum and a maximum value for the energy use and emissions, data is also given for a higher utilisation (81 %, the minimum value in the data) and a lower utilisation (49 %, the maximum value). Data for passenger planes was only given for a short flight distance (300 km) and a low average utilisation level (49 %) and a long flight distance (600 km) and a high average utilisation level (81%). The reason for this was to give an indication of a maximum and a minimum value of the energy use and emissions for goods carried in passenger planes in Swedish domestic traffic. To calculate energy use and emissions for other flight distances, the following relations may be used, where x=total distance in km. Kerosene: 2220 + 3,1*(x-300) [kg] CO2: 7015 + 9,8*(x-300) [kg] CO: 9,6 + 0,0129*(x-300) [kg] HC: 1,848 + 0,0049*(x-300) [kg] NOx: 29,85 + 0,031*(x-300) [kg] SO2: 2,22 + 0,003*(x-300) [kg] These relations are valid for flights longer than 300 km and concern a MD-82 loaded with 9450 kg i.e. a utilisation level equivalent to a passenger occupation of 65%.
About Data	The data is based on simulation calculations performed at FFA (Flygtekniska försöksanstalten).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Freighter, 2000-8000 dwt

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System

Name	Freighter, 2000-8000 dwt
Functional Unit	1 tonkm, 50-60 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers and 60% for other freighters. An utilisation level of 50 % for tankers and 60% for other freighters is representative for Swedish domestic traffic if *empty trips are included.*
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of Swedish flagged freighters between 2000 and 8000 dwt (deadweight tonnes), which are members of the Swedish Shipowners´ Association. Freighters include all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers and 60% for other freighters 60% (including empty trips) *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1990-01-01 - 1997-01-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The basis for the data are all Swedish flagged freighters between 2000 and 8000 deadweight tonnes, which are members of the Swedish Shipowners' Association. The *quantity value* for all parameters is an average of all vessels in the population. The *minimum value* corresponds to the individual with the lowest energy use and emissions in the population, and the *maximum value* to the individual with the largest energy use and emissions in the population. The *utilisation level* with regard to weight is 50 % for tankers and 60 % for other freighters, based on Demker et al. The energy use and emissions per tonkm for each vessel was calculated (see Specific QMetaData for each flow). For each vessel, the loading capacity was stated in deadweight tonnes (Skeppsregister 1995), installed engine power in kW (Skeppsregister 1995) and speed in knots (Lloyds list). The share of two-stroke and four-stroke engines in each vessel was determined by the size of the vessel according to Alexandersson. All vessels in the population were then used to calculate an average value.
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Demker, G. et al. *Miljöeffekter av transportmedelsval för godstransporter*, MariTerm, KFB-rapport, 1994:6 *Skeppsregister 1995*, Swedish Shipowner Association Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport

	1994:9 *Lloyds list*, 1996
Notes	The data is only valid for a flight distance of 600 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The oil consumption per tonkm were calculated using assumptions on the oil consumption for two stroke and four stroke engines (g/kWh, where kWh refer to mechanical work done by the engine). The following *equation* was used to calculate the oil consumption per tonkm for each vessel: (oil consumption[g/kWh]*installed engine power[kW]*thermal value[MJ/kg])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** -Oil consumption: 200 g/kWh for both two-stroke and four-stroke engines (based on Alexandersson). -Thermal value for the oil: 40 MJ/kg. See General QMetaData for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Notes: Modern engines have lower fuel consumption (down to 160g/kWh for slow speed engines).	Input	Refined resource	Heavy oil	0.279	0.144	0.401	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.0245	0.0108	0.0389	g	Air	
Method: See QMetaData for NOx	Output	Emission	CO2	21.328	11.077	30.8	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.0147	0.0062	0.0298	g	Air	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm are calculated from standard values for the specific emissions for two-stroke and four stroke engines at 80 % engine load. The standard values are given in g/kWh, where kWh refer to mechanical work done by the engine. The following *equation* was used to calculate the emissions per tonkm for each vessel: (spec. emission factor[g/kWh]*engine power[kW])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** *Specific emission factors:* The emission factors were given in Alexandersson and are based on measurements on the engine. Two stroke engines at 80 % engine load: -CO2 600 g/kWh -NOx 17,7 g/kWh -HC 0,8 g/kWh -CO 0,2 g/kWh -Particles 0,9 g/kWh Four stroke engines at 80 % engine load: -CO2 620 g/kWh -NOx 14 g/kWh -HC 0,2 g/kWh -CO 1 g/kWh -Particles 0,4 g/kWh See General QMetadata for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18	Output	Emission	NOx	0.535	0.268	0.754	g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.0204	0.0094	0.0342	g	Air	

Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the fuel. The following *equation* was used to calculate the emission for each vessel: 2*(oil consumption[g/kWh]*engine power[kW]* sulphur content)/(speed[km/h]*loading capacity[ton]*occupation) ***Data used in the calculations:*** -Sulphur content: 2,6 % (Sjöbris). -Oil consumption: 200 g/kWh for both two-stroke and four-stroke engines (Alexandersson). See General QMetaData for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 Notes: The average sulphur content for oil used in international traffic is 3,3 %. (Alexandersson)	Output	Emission	SO2	0.362	0.187	0.521	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 --- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Elisabeth Sörheim, Swedish Shipowners' Association, contact person for sea transports in the work of NGM ---
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Sörheim, Elisabeth - The Swedish Shipowners Association, Box 53046, S-400 14 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vessel, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out.

	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association. ***Type of vessels*** *Freighters* - includes all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc. Freighters are mainly used for transportation of heavy goods over large distances. The energy use for tankers is generally lower than for other freighters. *RoRo vessels* are used for transportation of different types of load carriers such as trailers, containers etc. The cargo is rolled on the vessel. RoRo vessels generally operate at a higher speed than regular freighters. *Ferries* carry both passengers and goods. The goods are carried in trucks or trains. ***Fuel*** The fuel quality may vary to a large extent between different vessels. Smaller vessels that only operate on Swedish routes generally use better fuels. The main part of freighters in Swedish traffic use heavy fuel oil, with a sulphur content of 2,6 %. Small coastal freighters may however use gas oil with sulphur content of 0,1 %. Gas oil is the most refined type of fuel used in vessels (the maximum sulphur content is 1,5 %). In ferries, low sulphur fuel with sulphur content of 0,5 % is generally used. Differentiated harbour dues on sulphur and NOx emissions were introduced in Sweden 1 January 1998. This will probably result in use of fuels of a better quality, primarily in ferries but also other freighters. ***Reduction of emissions*** The data does not assume the use of any emission reducing measures. Different measures may be taken to reduce the emissions, e.g. water injection may reduce the emissions of NOx by 50%, and adjustments of the engine may reduce NOx emissions by 30 %. Catalytic converters may reduce NOx emissions by 90-100% and HC by 70-80%. Emissions of particles and HC are also reduced. Installation of catalytic converters is however a large investment for the shipowners. There are at present only a few vessels in Swedish traffic that has installed catalytic converters. The other measures constitute a smaller investment, and it is anticipated that the shipowners will chose these techniques to reduce emissions. ***Bulky goods*** Vessels generally handle transportation of large heavy goods over long distances. Some bulky goods are however transported by sea, primarily by RoRo vessels and ferries. The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Travelled distance*** The travelled distance of the goods may be estimated using a Nautic almanac, Lloyd. Since the utilisation level includes empty trips, no compensation in the distance for empty trips needs to be done. ***International sea transports*** When using the data for international traffic, the sulphur emissions should be adjusted, since the fuel quality may vary. Representative sulphur content of fuel used in international traffic is 3,3 %. The energy use and emissions of other parameters may also vary to a large extent depending on the quality of the fuel.
About Data	The data for emissions is derived from specific emission factors for the engine at a constant 80 % engine load. No test cycle was used to obtain the emission factors. There is however a small need for test cycles, since vessels generally operate at constant load on the engine during the sail. The fact that the engine load sometimes is lower than 80 % i.e. when sailing to and from the harbour has been neglected. This part is generally small but complicated. The calculation model may be used to calculate the energy use and emissions for a specific vessel if the loading capacity, installed engine power etc. is known. This information may be obtained from Skeppsregister. See QMetaData for details.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different

	transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Freighter, 2000-8000 dwt, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Freighter, 2000-8000 dwt, future
Functional Unit	1 tonkm, 50-60 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers and 60% for other freighters. An utilisation level of 50 % for tankers and 60% for other freighters is representative for Swedish domestic traffic if *empty trips are included.*
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of Swedish flagged freighters between 2000 - 8000 dwt (deadweight tonnes) with new technology reducing the energy use and emissions (catalytic converters, energy saving measures etc.). Only members of the Swedish Shipowners´ Association are included. Freighters include all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents new technology, available today but not yet in use.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers and 60% for other freighters 60% (including empty trips) *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel

	-Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The energy use and emissions was calculated using *assumptions* on energy saving and emission reducing actions together with data for existing individual vessels with the *lowest energy use and emissions* within the population of Swedish flagged Freighters between 8000 an 2000 dwt, which are members of the Swedish Shipowners' Association vessels. The utilisation level with regard to weight is 50 % for tankers and 60% for other freighters. The assumptions were given by the Swedish Shipowners' Association. The data for energy use and emissions for the vessels that was the basis for the calculation, and a description on how the data was obtained, can be found in the activity with ObjectOfStudy.Name: *Freighter, 8000-2000 dwt* (in this database) or in ''Energi- och emissionsuppgifter för godstransporter''. The minimum value for the energy use and emissions was used in the calculation. The following percentages for the reduction of energy use and emissions was used in the calculation: -Oil consumption: 30 % (by different energy saving measures) -NOx: 93 % (through optimisation of the engine and catalytic converters) -HC: 88 % (by catalytic converters) -CO: 81 % (by catalytic converters) -Particles: 35 % The sulphur content in the fuel was assumed to be 0,09 %. Emissions of SO2 were calculated from the fuel consumption using the sulphur content in the fuel. Emissions of CO2 were calculated from the fuel consumption using the carbon content in the fuel.
Literature Reference	Energi- och emissionsuppgifter för godstransporter i Sverige, Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning 1997, NGM- Nätverket för Godstransporter och Miljön.
Notes	The data is only valid for a flight distance of 600 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Heavy oil	0.101			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	0.0021			g	Air	
	Output	Emission	CO2	7.754			g	Air	
	Output	Emission	HC	0.0007			g	Air	
	Output	Emission	NOx	0.009			g	Air	
	Output	Emission	Particles	0.0061			g	Air	
	Output	Emission	SO2	0.0065			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Elisabeth Sörheim, Swedish Shipowners' Association, contact person for sea transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the

	transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Sörheim, Elisabeth - The Swedish Shipowners Association, Box 53046, S-400 14 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions for Swedish flagged freighters between 8000 and 2000 dead weight tonnes. The data represents new technology (catalytic converters, energy saving measures etc), not yet in regular use. There are at present only a few vessels in Swedish traffic that has installed catalytic converters, since installation of catalytic converters is a large investment for the shipowners.
About Data	The data is based on assumptions on different energy saving and emission reducing actions together with data for existing vessels in Swedish traffic with the lowest energy use and emissions. The data was compiled by the Swedish Shipowners´ Association. See Flow QMetaData for further information.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Freighter, larger than 8000 dwt

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Freighter, larger than 8000 dwt
Functional Unit	1 tonkm, 50-60 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers and 60% for other freighters. An utilisation level of 50 % for tankers and 60% for other freighters is representative for Swedish domestic traffic if *empty trips are included.*
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of Swedish flagged freighters larger than 8000 dwt (deadweight tonnes), which are members of the Swedish Shipowners´ Association. Freighters include all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers and 60% for other freighters 60% (including empty trips) *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1990-01-01 - 1997-01-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The basis for the data are all Swedish flagged freighters larger than 8000 deadweight tonnes, which are members of the Swedish Shipowners' Association. The *quantity value* for all parameters is an average of all vessels in the population. The *minimum value* corresponds to the individual with the lowest energy use and emissions in the population, and the *maximum value* to the individual with the largest energy use and emissions in the population. The *utilisation level* with regard to weight is 50 % for tankers and 60% for other freighters, based on Demker et al. The energy use and emissions per tonkm for each vessel was calculated (see Specific QMetaData for each flow). For each vessel, the loading capacity was stated in deadweight tonnes (Skeppsregister 1995), installed engine power in kW (Skeppsregister 1995) and speed in knots (Lloyds list). The share of two-stroke and four-stroke engines in each vessel was determined by the size of the vessel according to Alexandersson. All vessels in the population were then used to calculate an average value.

Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Demker, G. et al. *Miljöeffekter av transportmedelsval för godstransporter*, MariTerm, KFB-rapport, 1994:6 *Skeppsregister 1995*, Swedish Shipowner Association Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 *Lloyds list*, 1996
Notes	The data is only valid for a flight distance of 600 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The oil consumption per tonkm were calculated using assumptions on the oil consumption for two stroke and four stroke engines (g/kWh, where kWh refer to mechanical work done by the engine). The following *equation* was used to calculate the oil consumption per tonkm for each vessel: (oil consumption[g/kWh]*installed engine power[kW]*thermal value[MJ/kg])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** -Oil consumption: 200 g/kWh for both two-stroke and four-stroke engines (based on Alexandersson). -Thermal value for the oil: 40 MJ/kg. See General QMetaData for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Notes: Modern engines have lower fuel consumption (down to 160g/kWh for slow speed engines).	Input	Refined resource	Heavy oil	0.201	0.052	0.3	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.0086	0.0013	0.0147	g	Air	
Method: See QMetaData for NOx	Output	Emission	CO2	15.131	3.882	22.562	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.0174	0.0052	0.0277	g	Air	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm are calculated from standard values for the specific emissions for two-stroke and four stroke engines at 80 % engine load. The standard values are given in g/kWh, where kWh refer to mechanical work done by the engine. The following *equation* was used to calculate the emissions per tonkm for each vessel: (spec. emission factor[g/kWh]*engine power[kW])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** *Specific emission factors:* The emission factors were given in Alexandersson and are based on measurements on the engine. Two stroke engines at 80 % engine load: -CO2 600 g/kWh -NOx 17,7 g/kWh -HC 0,8 g/kWh -CO 0,2 g/kWh -Particles 0,9 g/kWh Four stroke engines at 80 % engine load: -CO2 620 g/kWh -NOx 14 g/kWh -HC 0,2 g/kWh -CO 1 g/kWh -Particles 0,4 g/kWh See General QMetadata for further details. Literature: Alexandersson, A.,	Output	Emission	NOx	0.427	0.115	0.65	g	Air	

Sjöfartens utsläpp av avgaser, MariTerm, TFB-rapport 1991:18									
Method: See QMetaData for NOx	Output	Emission	Particles	0.0203	0.0058	0.0319	g	Air	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the fuel. The following *equation* was used to calculate the emission for each vessel: 2*(oil consumption[g/kWh]*engine power[kW]* sulphur content)/(speed[km/h]*loading capacity[ton]*occupation) ***Data used in the calculations:*** -Sulphur content: 2,6 % (Sjöbris). -Oil consumption: 200 g/kWh for both two-stroke and four-stroke engines (Alexandersson). See General QMetaData for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 Notes: The average sulphur content for oil used in international traffic is 3,3 %. (Alexandersson)	Output	Emission	SO2	0.261	0.067	0.39	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Elisabeth Sörheim, Swedish Shipowners' Association, contact person for sea transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Sörheim, Elisabeth - The Swedish Shipowners Association, Box 53046, S-400 14 Göteborg .
Reviewer	

	Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vessel, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association. ***Type of vessels*** *Freighters* - includes all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc. Freighters are mainly used for transportation of heavy goods over large distances. The energy use for tankers is generally lower than for other freighters. *RoRo vessels* are used for transportation of different types of load carriers such as trailers, containers etc. The cargo is rolled on the vessel. RoRo vessels generally operate at a higher speed than regular freighters. *Ferries* carry both passengers and goods. The goods are carried in trucks or trains. ***Fuel*** The fuel quality may vary to a large extent between different vessels. Smaller vessels that only operate on Swedish routes generally use better fuels. The main part of freighters in Swedish traffic use heavy fuel oil, with a sulphur content of 2,6 %. Small coastal freighters may however use gas oil with sulphur content of 0,1 %. Gas oil is the most refined type of fuel used in vessels (the maximum sulphur content is 1,5 %). In ferries, low sulphur fuel with sulphur content of 0,5 % is generally used. Differentiated harbour dues on sulphur and NOx emissions were introduced in Sweden 1 January 1998. This will probably result in use of fuels of a better quality, primarily in ferries but also other freighters. ***Reduction of emissions*** The data does not assume the use of any emission reducing measures. Different measures may be taken to reduce the emissions, e.g. water injection may reduce the emissions of NOx by 50%, and adjustments of the engine may reduce NOx emissions by 30 %. Catalytic converters may reduce NOx emissions by 90-100% and HC by 70-80%. Emissions of particles and HC are also reduced. Installation of catalytic converters is however a large investment for the shipowners. There are at present only a few vessels in Swedish traffic that has installed catalytic converters. The other measures constitute a smaller investment, and it is anticipated that the shipowners will chose these techniques to reduce emissions. ***Bulky goods*** Vessels generally handle transportation of large heavy goods over long distances. Some bulky goods are however transported by sea, primarily by RoRo vessels and ferries. The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Travelled distance*** The travelled distance of the goods may be estimated using a Nautic almanac, Lloyd. Since the utilisation level includes empty trips, no compensation in the distance for empty trips needs to be done. ***International sea transports*** When using the data for international traffic, the sulphur emissions should be adjusted, since the fuel quality may vary. Representative sulphur content of fuel used in international traffic is 3,3 %. The energy use and emissions of other parameters may also vary to a large extent depending on the quality of the fuel.
	About Data	The data for emissions is derived from specific emission factors for the engine at a constant 80 % engine load. No test cycle was used to obtain the emission factors. There is however a small need for test cycles, since vessels generally operate at constant load on the engine during the sail. The fact that the engine load sometimes is lower than 80 % i.e. when sailing to and from the harbour has been neglected. This part is generally small but complicated. The calculation model may be used to calculate the energy use and emissions for a specific vessel if the loading capacity, installed engine power etc. is known. This information may be obtained from Skeppsregister. See QMetaData for details.
	Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at

	the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Freighter, larger than 8000 dwt, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Freighter, larger than 8000 dwt, future
Functional Unit	1 tonkm, 50-60 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers and 60% for other freighters. An utilisation level of 50 % for tankers and 60% for other freighters is representative for Swedish domestic traffic if *empty trips are included.*
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of Swedish flagged freighters larger than 8000 dwt (deadweight tonnes) with new technology reducing the energy use and emissions (catalytic converters, energy saving measures etc.). Only members of the Swedish Shipowners´ Association are included. Freighters include all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents new technology, available today but not yet in use.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers and 60% for other freighters 60% (including empty trips) *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel

	Excluded subsystems -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The energy use and emissions was calculated using *assumptions* on energy saving and emission reducing actions together with data for existing individual vessels with the *lowest energy use and emissions* within the population of Swedish flagged freighters larger than 8000 dwt, which are members of the Swedish Shipowners' Association vessels. The utilisation level with regard to weight is 50 % for tankers and 60% for other freighters. The assumptions were given by the Swedish Shipowners' Association. The data for energy use and emissions for the vessels that was the basis for the calculation, and a description on how the data was obtained, can be found in the activity with ObjectOfStudy.Name: *Freighter, larger than 8000 dwt* (in this database) or in ''Energi- och emissionsuppgifter för godstransporter''. The minimum value for the energy use and emissions was used in the calculation. The following percentages for the reduction of energy use and emissions was used in the calculation: -Oil consumption: 30 % (by different energy saving measures) -NOx: 93 % (through optimisation of the engine and catalytic converters) -HC: 88 % (by catalytic converters) -CO: 81 % (by catalytic converters) -Particles: 35 % The sulphur content in the fuel was assumed to be 0,09 %. Emissions of SO2 were calculated from the fuel consumption using the sulphur content in the fuel. Emissions of CO2 were calculated from the fuel consumption using the carbon content in the fuel.
Literature Reference	Energi- och emissionsuppgifter för godstransporter i Sverige, Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning 1997, NGM- Nätverket för Godstransporter och Miljön.
Notes	The data is only valid for a flight distance of 600 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Heavy oil	0.036			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	0.0002			g	Air	
	Output	Emission	CO2	2.717			g	Air	
	Output	Emission	HC	0.0006			g	Air	
	Output	Emission	NOx	0.004			g	Air	
	Output	Emission	Particles	0.0038			g	Air	
	Output	Emission	SO2	0.0023			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 --- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Elisabeth Sörheim, Swedish Shipowners' Association, contact person for sea transports in the work of NGM ---
Intended User	Suppliers and buyers of goods

General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Sörheim, Elisabeth - The Swedish Shipowners Association, Box 53046, S-400 14 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions for Swedish flagged freighters larger than 8000 dead weight tonnes. The data represents new technology (catalytic converters, energy saving measures etc), not yet in regular use. There are at present only a few vessels in Swedish traffic that has installed catalytic converters, since installation of catalytic converters is a large investment for the shipowners.
About Data	The data is based on assumptions on different energy saving and emission reducing actions together with data for existing vessels in Swedish traffic with the lowest energy use and emissions. The data was compiled by the Swedish Shipowners´ Association. See Flow QMetaData for further information.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Freighter, smaller than 2000 dwt

Administrative	
Finished	Y
Date Completed	1997-11-19

Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Freighter, smaller than 2000 dwt
Functional Unit	1 tonkm, 50-60 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers and 60% for other freighters. An utilisation level of 50 % for tankers and 60% for other freighters is representative for Swedish domestic traffic if *empty trips are included.*
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of Swedish flagged freighters smaller than 2000 dwt (deadweight tonnes), which are members of the Swedish Shipowners´ Association. Freighters include all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers and 60% for other freighters 60% (including empty trips) *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1990-01-01 - 1997-01-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The basis for the data are all Swedish flagged freighters smaller than 2000 deadweight tonnes (and larger than 300 BRT), which are members of the Swedish Shipowners' Association. The *quantity value* for all parameters is an average of all vessels in the population. The *minimum value* corresponds to the individual with the lowest energy use and emissions in the population, and the *maximum value* to the individual with the largest energy use and emissions in the population. The *utilisation level* with regard to weight is 50 % for tankers and 60% for other freighters, based on Demker et al. The energy use and emissions per tonkm for each vessel was calculated (see Specific QMetaData for each flow).

	For each vessel, the loading capacity was stated in deadweight tonnes (Skeppsregister 1995), installed engine power in kW (Skeppsregister 1995) and speed in knots (Lloyds list). The share of two-stroke and four-stroke engines in each vessel was determined by the size of the vessel according to Alexandersson. All vessels in the population were then used to calculate an average value.
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Demker, G. et al. *Miljöeffekter av transportmedelsval för godstransporter*, MariTerm, KFB-rapport, 1994:6 *Skeppsregister 1995*, Swedish Shipowner Association Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 *Lloyds list*, 1996
Notes	The data is only valid for a flight distance of 600 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The oil consumption per tonkm were calculated using assumptions on the oil consumption for two stroke and four stroke engines (g/kWh, where kWh refer to mechanical work done by the engine). The following *equation* was used to calculate the oil consumption per tonkm for each vessel: (oil consumption[g/kWh]*installed engine power[kW]*thermal value[MJ/kg])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** -Oil consumption: 200 g/kWh for both two-stroke and four-stroke engines (based on Alexandersson). -Thermal value for the oil: 40 MJ/kg. See General QMetaData for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18	Input	Refined resource	Heavy oil	0.39	0.16	0.68	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.0417	0.0155	0.084	g	Air	
Method: See QMetaData for NOx	Output	Emission	CO2	30	12	53	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.0155	0.0074	0.0225	g	Air	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm are calculated from standard values for the specific emissions for two-stroke and four stroke engines at 80 % engine load. The standard values are given in g/kWh, where kWh refer to mechanical work done by the engine. The following *equation* was used to calculate the emissions per tonkm for each vessel: (spec. emission factor[g/kWh]*engine power[kW])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** *Specific emission factors:* The emission factors were given in Alexandersson and are based on measurements on the engine. Two stroke engines at 80 % engine load: -CO2 600 g/kWh -NOx 17,7 g/kWh -HC 0,8 g/kWh -CO 0,2 g/kWh -Particles 0,9 g/kWh Four stroke engines at 80 % engine load: -CO2 620 g/kWh -NOx 14 g/kWh -HC 0,2 g/kWh -CO 1 g/kWh -Particles 0,4 g/kWh See General	Output	Emission	NOx	0.73	0.3	1.2	g	Air	

QMetadata for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18									
Method: See QMetaData for NOx	Output	Emission	Particles	0.0245	0.0108	0.035	g	Air	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the fuel. The following *equation* was used to calculate the emission for each vessel: 2*(oil consumption[g/kWh]*engine power[kW]* sulphur content)/(speed[km/h]*loading capacity[ton]*occupation) ***Data used in the calculations:*** -Sulphur content: 2,6 % (Sjöbris). -Oil consumption: 200 g/kWh for both two-stroke and four-stroke engines (Alexandersson). See General QMetaData for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 Notes: The average sulphur content for oil used in international traffic is 3,3 %. (Alexandersson)	Output	Emission	SO2	0.51	0.21	0.89	g	Air	

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Elisabeth Sörheim, Swedish Shipowners' Association, contact person for sea transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Sörheim, Elisabeth - The Swedish Shipowners Association, Box 53046, S-400 14 Göteborg .

Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vessel, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association. ***Type of vessels*** *Freighters* - includes all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc. Freighters are mainly used for transportation of heavy goods over large distances. The energy use for tankers is generally lower than for other freighters. *RoRo vessels* are used for transportation of different types of load carriers such as trailers, containers etc. The cargo is rolled on the vessel. RoRo vessels generally operate at a higher speed than regular freighters. *Ferries* carry both passengers and goods. The goods are carried in trucks or trains. ***Fuel*** The fuel quality may vary to a large extent between different vessels. Smaller vessels that only operate on Swedish routes generally use better fuels. The main part of freighters in Swedish traffic use heavy fuel oil, with a sulphur content of 2,6 %. Small coastal freighters may however use gas oil with sulphur content of 0,1 %. Gas oil is the most refined type of fuel used in vessels (the maximum sulphur content is 1,5 %). In ferries, low sulphur fuel with sulphur content of 0,5 % is generally used. Differentiated harbour dues on sulphur and NOx emissions were introduced in Sweden 1 January 1998. This will probably result in use of fuels of a better quality, primarily in ferries but also other freighters. ***Reduction of emissions*** The data does not assume the use of any emission reducing measures. Different measures may be taken to reduce the emissions, e.g. water injection may reduce the emissions of NOx by 50%, and adjustments of the engine may reduce NOx emissions by 30 %. Catalytic converters may reduce NOx emissions by 90-100% and HC by 70-80%. Emissions of particles and HC are also reduced. Installation of catalytic converters is however a large investment for the shipowners. There are at present only a few vessels in Swedish traffic that has installed catalytic converters. The other measures constitute a smaller investment, and it is anticipated that the shipowners will chose these techniques to reduce emissions. ***Bulky goods*** Vessels generally handle transportation of large heavy goods over long distances. Some bulky goods are however transported by sea, primarily by RoRo vessels and ferries. The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Travelled distance*** The travelled distance of the goods may be estimated using a Nautic almanac, Lloyd. Since the utilisation level includes empty trips, no compensation in the distance for empty trips needs to be done. ***International sea transports*** When using the data for international traffic, the sulphur emissions should be adjusted, since the fuel quality may vary. Representative sulphur content of fuel used in international traffic is 3,3 %. The energy use and emissions of other parameters may also vary to a large extent depending on the quality of the fuel.
About Data	The data for emissions is derived from specific emission factors for the engine at a constant 80 % engine load. No test cycle was used to obtain the emission factors. There is however a small need for test cycles, since vessels generally operate at constant load on the engine during the sail. The fact that the engine load sometimes is lower than 80 % i.e. when sailing to and from the harbour has been neglected. This part is generally small but complicated. The calculation model may be used to calculate the energy use and emissions for a specific vessel if the loading capacity, installed engine power etc. is known. This information may be obtained from Skeppsregister. See QMetaData for details.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is

	expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Freighter, smaller than 2000 dwt, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Freighter, smaller than 2000 dwt, future
Functional Unit	1 tonkm, 50-60 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers and 60% for other freighters. An utilisation level of 50 % for tankers and 60% for other freighters is representative for Swedish domestic traffic if *empty trips are included.*
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of Swedish flagged freighters smaller than 2000 dwt (deadweight tonnes) with new technology reducing the energy use and emissions (catalytic converters, energy saving measures etc.). Only members of the Swedish Shipowners´ Association are included. Freighters include all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc..

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents new technology, available today but not yet in use.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers and 60% for other freighters 60% (including empty trips) *Parameters not considered* -Driving technique

	-External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The energy use and emissions was calculated using *assumptions* on energy saving and emission reducing actions together with data for existing individual vessels with the *lowest energy use and emissions* within the population of Swedish flagged freighters smaller than 2000 dwt, which are members of the Swedish Shipowners' Association vessels. The utilisation level with regard to weight is 50 % for tankers and 60% for other freighters%. The assumptions were given by the Swedish Shipowners' Association. The data for energy use and emissions for the vessels that was the basis for the calculation, and a description on how the data was obtained, can be found in the activity with ObjectOfStudy.Name: *Freighter, smaller than 2000dwt* (in this database) or in ''Energi- och emissionsuppgifter för godstransporter''. The minimum value for the energy use and emissions was used in the calculation. The following percentages for the reduction of energy use and emissions was used in the calculation: -Oil consumption: 30 % (by different energy saving measures) -NOx: 93 % (through optimisation of the engine and catalytic converters) -HC: 88 % (by catalytic converters) -CO: 81 % (by catalytic converters) -Particles: 35 % The sulphur content in the fuel was assumed to be 0,09 %. Emissions of SO2 were calculated from the fuel consumption using the sulphur content in the fuel. Emissions of CO2 were calculated from the fuel consumption using the carbon content in the fuel.
Literature Reference	Energi- och emissionsuppgifter för godstransporter i Sverige, Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning 1997, NGM- Nätverket för Godstransporter och Miljön.
Notes	The data is only valid for a flight distance of 600 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Heavy oil	0.11			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	0.003			g	Air	
	Output	Emission	CO2	8.6			g	Air	
	Output	Emission	HC	0.0009			g	Air	
	Output	Emission	NOx	0.011			g	Air	
	Output	Emission	Particles	0.007			g	Air	
	Output	Emission	SO2	0.0072			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Elisabeth Sörheim, Swedish Shipowners' Association, contact person for sea transports in the work of NGM --
Intended User	Suppliers and buyers of goods

General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Sörheim, Elisabeth - The Swedish Shipowners Association, Box 53046, S-400 14 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions for Swedish flagged freighters smaller than 2000 dead weight tonnes. The data represents new technology (catalytic converters, energy saving measures etc), not yet in regular use. There are at present only a few vessels in Swedish traffic that has installed catalytic converters, since installation of catalytic converters is a large investment for the shipowners.
About Data	The data is based on assumptions on different energy saving and emission reducing actions together with data for existing vessels in Swedish traffic with the lowest energy use and emissions. The data was compiled by the Swedish Shipowners´ Association. See Flow QMetaData for further information.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Freight-Train Luleå to Halmstad

Administrative	
Finished	Y
Date Completed	1999-04-20

Copyright	
Availability	public

Technical System

Name	Freight-Train Luleå to Halmstad
Functional Unit	150 m3 waste oil transported from Luleå to Halmstad
Functional Unit Explanation	
Process Type	Gate to gate
Site	
Sector	Land transport
Owner	
Technical system description	The transportation of waste oil from Luleå to Halmstad, 1280 km. The density for the waste oil is 0,93 ton / m3 due to the water pollution. Totally was 150 m3 transported during 1997.

System Boundaries

Nature Boundary	
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions.
Geographical Boundary	The geographical boundary is set to Sweden.
Other Boundaries	The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. No spill occurs The loading and unloading steps are neglected in terms of consuming resources and emissions. The electricity utilised by the system is only seen as an resource and the origin is not interpreted.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998-12-29
Data Type	Monitored data, continuous
Represents	See 'Function'.
Method	NTM presents data concerning the energy consumption for the freight train per tonkm. The transportation of waste oil from Luleå to Halmstad, 1280 km. The density for the waste oil is 0,93 ton / m3 due to the water pollution. Totally was 150 m3 transported during 1997.
Literature Reference	http://www.ntm.a.ase/emissioner/train/inledning/htm
Notes	The data is only valid for a flight distance of 600 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Waste oil	150			m3	Technosphere	
	Input	Refined resource	Electricity	7142			kWh	Technosphere	Sweden
	Output	Cargo	Waste oil	150			m3	Technosphere	

About Inventory	
Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology -- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Internal use at Reci Industri
General Purpose	The objective of this thesis was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000 certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use during transportation by train.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	Data are valid for average freight-train in Sweden.
About Data	If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as a supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Freight-Train Umeå to Halmstad

Administrative	
Finished	Y
Date Completed	1999-04-20
Copyright	
Availability	public

Technical System	
Name	Freight-Train Umeå to Halmstad
Functional Unit	1661 m3 waste oil transported from Umeå to Halmstad.
Functional Unit Explanation	
Process Type	Gate to gate
Site	
Sector	Land transport
Owner	
Technical system description	The transportation of waste oil fromUmeå to Halmstad, 1020 km. The density for the waste oil is 0,93 ton / m3 due to the water pollution. Totally was 1661 m3 transported during 1997.

System Boundaries	
Nature Boundary	
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions.
Geographical Boundary	The geographical boundary is set to Sweden.
Other Boundaries	The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. No spill occurs The loading and unloading steps are neglected in terms of consuming resources and emissions. The electricity utilised by the system is only seen as an resource and the origin is not interpreted.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1998-12-29
Data Type	Monitored data, continuous
Represents	See 'Function'.
Method	NTM presents data concerning the energy consumption for the freight train per tonkm. The transportation of waste oil fromUmeå to Halmstad, 1020 km. The density for the waste oil is 0,93 ton / m3 due to the water pollution. Totally was 1661 m3 transported during 1997.
Literature Reference	http://www.ntm.a.ase/emissioner/train/inledning/htm
Notes	The data is only valid for a flight distance of 600 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Waste oil	1661			m3	Technosphere	
	Input	Refined resource	Electricity	63025			kWh	Technosphere	Sweden
	Output	Cargo	Waste oil	1661			m3	Technosphere	

About Inventory	
Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology -- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Internal use at Reci Industri
General Purpose	The objective of this thesis was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000 certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use during transportation by train.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.

Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	Data are valid for average freight-train in Sweden.
About Data	If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as a supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Fuel gas electricity energy system, EPD-version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Fuel gas electricity energy system, EPD-version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant istself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures are based on data from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996 and adapted to the demands of the EPD-guidelines (Environmental Product Declaration guidelines in Sweden). -- Brief description -- The phases inventoried in ETH's life cycle study of electricity generation with fuel gas (74,5% natural gas 36 MJ/m3, 6,9% coke oven gas 18 MJ/m3, 18,6% blast furnace gas 3,3 MJ/m3) are: exploration of natural gas, extraction (onshore and offshore), processing, long distance transport and storage, regional distribution and power plant operation. The average situation in the UCPTE* region in 1994 concerning the origin of the gas, compression and transport, processing (of gas with more or less sulphur content), distribution, power plant operation etc. is described. About 15% of the natural gas is extracted together with crude oil and 20% of natural gas used in the UCPTE is extracted offshore. Coke oven gas is produced in a cokery out of stone coal but is not described in detail in this documentation (see metadata in ''Stone coal electricity energy system, EPD-version'' and the original ETH study) but blast furnace gas is seen as a byproduct in steel production and is not charged with any environmental impact for its supply in this study. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle. -- Detailed description -- Exploration of natural gas

Drilling activities during exploration of natural gas have been inventoried regarding use of energyware, drilling chemicals, water, steel and concrete (coating of drilling holes) and use of land/sea bed (not included in the figures reported here, see other boundaries). Besides emissions arising due to use of energyware also emissions of methane and other volatile organic compounds from the drilling holes are included. Natural gas/crude oil emanating in drilling test is burnt, emissions are included.
Offshore exploration leads to emissions of drilling chemicals and drilling sludge to the sea, though a lot of it is cleaned on the platform before it is emitted. Other emissions to the sea are heavy metals from the drilled sea bed, oil and intraformation water. Some of the drilling chemicals and sludge is brought to the shore as waste.
Waste of onshore activities are of the same kind. It is put in landfills, in land farming or casted (emissions from these processes are included).

Extraction of natural gas
Average on- and offshore extraction has been inventoried regarding construction and demolition of platforms, towers, pipelines etc., use of energyware, materials (steel and concrete) and land/sea bed.
A first processing step of natural gas to remove sulphur (for gases with a high sulphur content, H2S > 1% by volume) is included as well as flaring of gas, leaks, blow-outs and low pressure venting (emissions of mercury and radioactive radon are accounted for since these elements are found in the gas).
Compression is used in the extracting process, for transportation to processing plant (onshore about 50 km) and for compensation of pressure losses in the processing plant. Gas turbines are used (10-20 MW) driven by not yet processed natural gas, raw gas.
Extraction of gas together with crude oil gives a higher energyware consumption than extraction of natural gas alone due to larger compression and processing need.
Production of production chemicals, for ex. anticorrosives, and drilling chemicals as well as emissions of those chemicals is included based on rough estimations.
Onshore, most of the intraformation water is assumed to be pumped into hollows deep in the ground the rest is led into a fresh water recipient. Offshore most of the intraformation water is emitted to the sea.
Shipping of supplies is included.
Production waste consists of scale i.e. mineral deposits in equipment and pipelines. Scale is low level radioactive.

Processing of natural gas
Processing implies removal of water and oil, higher hydrocarbons, sulphur (efficiency 98%), mercury and radon as well as gas drying. Processing of gas with a higher sulphur content is often done onshore and is supplied by grid electricity while gas with a low sulphur content often is processed in the field (supply by gas turbines). Construction phase and operation phase is included (also flaring and leaks). Processed gas has a lower heating value of 34.4 MJ/m3 (density 0.8 kg/m3, 70% methane, sulphur content 0,002 g/m3).

Long-distance transports of natural gas
The average transport situation has been scanned. Transport in pipeline implies compression of the gas in several compressor stations with several natural gas driven gas turbines (10-20 MW). The average natural gas flow varies with pipeline, 0,77-1 milion m3 per h. Average transport distances are 800 km from the Netherlands, 1500 km from Norway, 800 km from Germany, 2500 km from Algeria and 6000 km from the former Soviet Union. Leakage rates for Russian natural gas are 0,5% for gas production and 1,5% for long distance transportation to Europe. For long distance transportation from other countries, a leakage rate of 0.01% per 1000 km is applied.
Construction of pipelines and seasonal storages (about 10% /year of the gas is stored), leaks, condensate separators, incineration of condensate and inspection flights are included.
64% of imported gas from Algeria is liquified (LNG): 15% of this gas is consumed for cooling of the gas. Transport is done by ship. Construction of gas containers is included but not of the ships themselves. Leaks are included.

Regional distribution of natural gas
The regional distribution implies gauging stations and pressure reducing stations, no further compressor stations are needed since the pressure from the long distance pipelines is enough. The regional distribution is however charged by some compression work done in the long distance pipeline system (0,2% of gas transported in the regional distribution network). The average transportation distance is set to 100 km. Medium gas flow: 30,3 TJ/km. Inspections and leaks are included.

Power plant for fuel gas
Fuel gas power plants are mainly used as top load plants with a low medium load (20%). Operation time is about 1800 h/year and electric efficiency is 39%. Fuel mix has been calculated from national statistics (including natural gas, coke oven gas and blast furnace gas) and fuel used for heat production (3,3% of total amount fuel gas used in the UCPTE) has been substracted. Construction and demolition of a 100 MWe steam turbin power plant has been inventoried. Data concerning operation emissions, water use and wastes has been found in literature and in public statistics and has been adapted to the UCPTE fuel gas mix.

* Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries

Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Manufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH. Vattenfall's criterion in selecting and aggregating ETH's LCI-results for electricity generation in the UCPTE region has been to make the figures usable as general electricity LCI data in EPDs according to Miljöstyrningsrådets guidelines. Especially parameters (emissions) which have established impact indices - accepted by the EPD system - for one or several environmental impact categories, have been picked out and aggregated as far possible. But also metal and energyware resources have been included, as well as waste, in spite of all waste handling processes related to this dataset being included with respect to use of resources and emissions. The latter is an adaption to other LCI data for electricity generation where waste amounts are reported (since those flows have not been followed to the grave). Since ETH claimes that most of the figures regarding metal emissions have an undefined amount of datagaps all metal emissions are aggregated except for a few which are specified separatly since they are reported for most processes in the lifecycle. Metals are reported as elements although they often are part of compounds. Measuring methods often just give the amounts of the different elements found. All hydrocarbons to water are aggregated to one parameter as well as halogenated organics, since no indices exist (that are accepted by the EPD system so far) for characterisation of the individual substances.
Time Boundary	Most of statistic figures used are from 1990 to 1994. For the calulation of the UCPTE gas electricity, fuel use in Europe of the year 1993 has been used. Data concerning material, chemical and energyware use are partly older. Figures concerning other fuel extraction and processing represent an average of the early nineties. Descriptions and figures of different technical processes come from literature, contractors, public and private institutions and describe the situation of the late eighties. Electricity used during the lifecycle has been assumed to be a mix based on the average generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years). All processes, also those conducted in the past, have been assumed to use average technology of the early nineties. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Pipelines in the gas field 30 years Pipelines, long distance 50 years Pipelines, regional distribution 40 years Power plant 30 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	Most important supplier countries of natural gas in the UCPTE are the Netherlands (39%), the states of the former Soviet Union (22%), Algeria (11%), Norway (9%) and Germany (7%). The rest comes mainly from Italy, France and Denmark (these countries are not included in this study, approximated with German figures). Only the Swiss regional distribution net for natural gas has been inventoried as a whole. Resulting figures have been adapted to UCPTE* conditions. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

Other Boundaries	Dismantling process of platforms is not included and the whole platform including drillhole mantelings and pipelines are assumed to be deposited, i.e. no recycling. Manufacture of needed chemicals in the processing plant for natural gas is neglected as well as the their transport. Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. The ETH study comprises figures concerning use of land, usable content in water storages and amount of turbine water which have not been reported here. The two latter have been excluded due to lack of corresponding data in comparable studies. Use of land has been excluded here because of ETH's advanced approach. Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the industrial revolution I Modified human impact larger than other species', low degree of cultivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of interest. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is different from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH specifies about 160 radioactive isotopes emitted to air and water. Radioactive emissions reported here are picked out in accordance with SETAC working group report on data quality and data availability (to be published in 2001). Big accidents occuring seldomly are not included.The threshold is fixes at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	Allocation of pipelines to the produced amount of gas is difficult. The total gas distribution network has been inventoried and related to the total amount of transported gas in 1994 assuming that this is representative. Allocation between natural gas and crude oil when extracted together has been conducted according to the lower heating value. Allocation between electricity and heat in fuel gas power plants has been done according to exergy. The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	The data has been adapted from the Ökoinventare von Energiesystemen, ETH Zürich 1996 and is an aggregation of the LCI results for the module ''Electricity from fuel gas power plant UCPTE-mix'' (Strom ab Brenngas-Kraftwerk UCPTE-Mix).
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative

	Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	The data is only valid for a flight distance of 600 km The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Bauxite	15.5			kg	Ground	
	Input	Natural resource	Chromium in ore	0.105			kg	Ground	
	Input	Natural resource	Copper in ore	4.39			kg	Ground	
Notes: From drillhole	Input	Natural resource	Crude oil	1260			kg	Ground	
Notes: Before processing	Input	Natural resource	Hard coal	12100			kg	Ground	
	Input	Natural resource	Iron in ore	458			kg	Ground	
	Input	Natural resource	Lead in ore	0.0578			kg	Ground	
Notes: Before extraction	Input	Natural resource	Lignite	265			kg	Ground	
	Input	Natural resource	Limestone	200			kg	Ground	
	Input	Natural resource	Manganese in ore	0.0576			kg	Ground	
Notes: Summation of ''Erdoelgas'' (40,9 MJ/Nm3), ''Grubengas'' (35,9 MJ/kg) and ''Rohgas'' (35 MJ/Nm3). Expressed as Natural gas with lower heating value (35 MJ/Nm3). The heating values are acquired from table III 8.1 in the methodology chapter in the Ökoinventare von Energiesystemen, ETH, Zürich 1996	Input	Natural resource	Natural gas	59112			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.0483			kg	Ground	
	Input	Natural resource	Palladium in ore	3.13E-07			kg	Ground	
	Input	Natural resource	Platinum in ore	3.54E-07			kg	Ground	
	Input	Natural resource	Rhodium in ore	3.33E-07			kg	Ground	
	Input	Natural resource	Rock salt	17			kg	Ground	
	Input	Natural resource	Uranium in ore	0.0183			kg	Ground	
	Input	Natural resource	Water	6.08E+05			kg	Ground	
	Input	Natural resource	Wood	104			kg	Ground	
	Input	Natural resource	Zinc in ore	0.0019			kg	Ground	
Notes: Summation of Ag, Sn, Rh, Mo, Co.	Input	Refined resource	Metals	6.16E-03			kg	Technosphere	
	Output	Emission	1,2-Dichloroethane	3.30E-05			kg	Air	
	Output	Emission	Ag-110m	0.0513			kBq	Water	
	Output	Emission	Ag-110m	7.52E-06			kBq	Air	
	Output	Emission	Am-241	0.0185			kBq	Water	
	Output	Emission	Am-241	1.41E-04			kBq	Air	
Notes: BOD5	Output	Emission	BOD	9.06E-02			kg	Water	
	Output	Emission	C-14	0.939			kBq	Water	
	Output	Emission	C-14	11.4			kBq	Air	
	Output	Emission	C-60	3.19E-04			kBq	Air	

	Output	Emission	Cd	1.19E-03			kg	Water	
	Output	Emission	Cd	2.62E-06			kg	Ground	
	Output	Emission	Cd	2.87E-04			kg	Air	
	Output	Emission	CFC-11	5.79E-06			kg	Air	
	Output	Emission	CFC-114	1.53E-04			kg	Air	
	Output	Emission	CFC-12	1.25E-06			kg	Air	
	Output	Emission	CFC-13	7.82E-07			kg	Air	
	Output	Emission	Cm alpha	0.0246			kBq	Water	
	Output	Emission	Cm alpha	2.23E-04			kBq	Air	
	Output	Emission	Cm-244	6.70E-09			kBq	Air	
	Output	Emission	CN-	1.65E-02			kg	Water	
Notes: CN- is Cyanide ion	Output	Emission	CN-	6.36E-04			kg	Air	
	Output	Emission	CO	81.973			kg	Air	
	Output	Emission	CO2	245831			kg	Air	
	Output	Emission	Co-58	0.0854			kBq	Water	
	Output	Emission	Co-58	2.13E-04			kBq	Air	
	Output	Emission	Co-60	4.1114			kBq	Water	
	Output	Emission	COD	0.8777			kg	Water	
	Output	Emission	Cr	2.04E-01			kg	Water	
	Output	Emission	Cr	5.59E-03			kg	Ground	
	Output	Emission	Cr	8.12E-04			kg	Air	
	Output	Emission	Cs-134	0.9497			kBq	Water	
	Output	Emission	Cs-134	5.35E-03			kBq	Air	
	Output	Emission	Cs-137	0.0103			kBq	Air	
	Output	Emission	Cs-137	8.7452			kBq	Water	
	Output	Emission	Dichloromethane	8.15E-05			kg	Air	
Notes: 2,3,7,8-Tetrachlorodibenzo-p-Dioxin-equivalents	Output	Emission	Dioxin (TCDD)	1480			ng	Air	
	Output	Emission	Dissolved solids	7.7			kg	Water	
	Output	Emission	H-1301	4.88E-04			kg	Air	
	Output	Emission	H2S	1.102			kg	Air	
	Output	Emission	H-3	116			kBq	Air	
	Output	Emission	H-3	2.78E+04			kBq	Water	
Notes: Summation of AOX, 1,1,1-trichloroethane, chlorobenzene, dichloromonofluoromethane, ethylene dichloride, hexachlororethane, metylenchloride, tetrachloroethylene, trichloroethylene, trichloromethane.	Output	Emission	Halogenated organics	8.08E-03			kg	Water	
Notes: Summation of Cl-, F- and I-.	Output	Emission	Halogenids	1.78E+02			kg	Water	
Notes: Summation of I and Br.	Output	Emission	Halogens	1.85E-03			kg	Air	
	Output	Emission	HCFC-21	7.92E-04			kg	Air	
	Output	Emission	HCFC-22	1.38E-06			kg	Air	
	Output	Emission	HCl	0.2215			kg	Air	
Notes: No available index. Same index as NMVOC.	Output	Emission	Hexachlorobenzene	9.53E-10			kg	Air	
	Output	Emission	Hexafluoroethane	1.69E-04			kg	Air	
	Output	Emission	HF	0.02825			kg	Air	
	Output	Emission	HFC-134a	-2.85E-15			kg	Air	
	Output	Emission	Hg	1.07E-06			kg	Ground	
	Output	Emission	Hg	2.25E-04			kg	Water	
	Output	Emission	Hg	7.48E-04			kg	Air	
Notes: Summation of acenaphtene, acenaphtylene, alkane, alkene, aromats, benzene, butyl benzyl phtalat, bibutyl p-phtalat, dimethyl p-phtalat, ethylbenzen, volatile hydrocarbons, formaldehyd, glutaraldehyd, hydrocarbons, MTBE (Metyl Tertiary Butyl Eter), phenol, styrol, toluol, triethylenglycol, xylol.	Output	Emission	Hydrocarbons	1.17E+00			kg	Water	
	Output	Emission	I-129	0.0402			kBq	Air	
	Output	Emission	I-129	2.68			kBq	Water	

	Output	Emission	I-131	0.00183			kBq	Water	
	Output	Emission	I-131	0.0047			kBq	Air	
	Output	Emission	I-133	0.000489			kBq	Water	
	Output	Emission	I-133	0.00249			kBq	Air	
	Output	Emission	K-40	0.0329			kBq	Air	
	Output	Emission	K-40	0.0693			kBq	Water	
	Output	Emission	Kr-85	6.93E+05			kBq	Air	
Notes: Summation of the ions of following metals: Ag, Al, Ar, Ba, Be, Cs, Ca, Fe, K, Co, Mg, Mn, Mo, Na, Ni, Ru, Sb, Se, Sn, Sr, Ti, W.	Output	Emission	Metal ions	1.26E+02			kg	Water	
Notes: Summation of Al, As, Ba, Be, Ca, Co, Cu, Fe, K, La, Mg, Mn, Mo, Ni, Pt, Sb, Sc, Se, Sn, Sr, Th, Ti, Tl, U, Zr.	Output	Emission	Metals	4.44E-01			kg	Air	
Notes: Summation of Al, As, Ca, Co, Cu, Fe, Mn, Ni, Sn.	Output	Emission	Metals	7.88E+00			kg	Ground	
	Output	Emission	Methane	373.7197			kg	Air	
	Output	Emission	Mn-54	0.63			kBq	Water	
	Output	Emission	Mn-54	7.65E-06			kBq	Air	
	Output	Emission	N	9.18E-04			kg	Ground	
	Output	Emission	N total	0.27019			kg	Water	
	Output	Emission	N2O	1.49689			kg	Air	
	Output	Emission	NH3	0.0601			kg	Air	
Notes: Summation of acetaldehyd, acetylene, aceton, acrolein, aldehyd, alkane, alkene, aromats, benzaldehyd, benzene, butan, buten, acetic acid, etan, etanol, etene, ethylbenzene, ethylenoxide (C2H4O), formaldehyd, heptan, hexan, metanol, MTBE (Metyl Tertiary Butyl Eter), NMVOC, pentane, phenol, propan, propen, propion aldehyd, propionic acid, styrol, toluol, xylol.	Output	Emission	NMVOC	6.20E+01			kg	Air	
	Output	Emission	NO2-	1.08E-03			kg	Water	
	Output	Emission	NO3-	0.0899			kg	Water	
Notes: as NO2	Output	Emission	NOx	408.44			kg	Air	
	Output	Emission	Np-237	0.00118			kBq	Water	
	Output	Emission	Oil	2.96E+00			kg	Water	
	Output	Emission	Oil	5.85E-02			kg	Ground	
	Output	Emission	P	0.0606			kg	Ground	
	Output	Emission	P total	9.89E-04			kg	Air	
	Output	Emission	PAH	1.01E-03			kg	Water	
Notes: Same index as NMVOC.	Output	Emission	PAH	2.16E-02			kg	Air	
	Output	Emission	Particles	16.1341			kg	Air	
	Output	Emission	Pb	1.07E-01			kg	Water	
	Output	Emission	Pb	4.04E-05			kg	Ground	
	Output	Emission	Pb	4.05E-03			kg	Air	
	Output	Emission	Pb-210	0.0552			kBq	Water	
	Output	Emission	Pb-210	0.1668			kBq	Air	
Notes: C6HCl5, no available index. Same index as NMVOC.	Output	Emission	Pentachlorobenzene	2.55E-09			kg	Air	
Notes: C6HCl5O, no available index. Same index as NMVOC.	Output	Emission	Pentachlorophenol	4.11E-10			kg	Air	
	Output	Emission	Po-210	0.0552			kBq	Water	
	Output	Emission	Po-210	0.2618			kBq	Air	
	Output	Emission	PO43-	1.19E+00			kg	Water	
	Output	Emission	Pu alpha	0.000447			kBq	Air	
	Output	Emission	Pu alpha	0.0738			kBq	Water	
	Output	Emission	Pu-238	1.67E-08			kBq	Air	
	Output	Emission	Ra-226	0.17			kBq	Air	
	Output	Emission	Ra-226	347.59			kBq	Water	
	Output	Emission	Rn-222	1.11E+04			kBq	Air	
Notes: Long-term emissions of Rn-222	Output	Emission	Rn-222	9.95E+05			kBq	Air	
	Output	Emission	Ru-106	0.0447			kBq	Air	
	Output	Emission	Ru-106	4.47			kBq	Water	

	Output	Emission	S	0.671			kg	Ground	
Notes: Includes Tot-S, S-, S in H2S, S in sulphate, S in sulphite	Output	Emission	S total	3.68E+01			kg	Water	
	Output	Emission	Sb-124	0.0134			kBq	Water	
	Output	Emission	Sb-124	2.07E-06			kBq	Air	
	Output	Emission	Sb-125	0.000872			kBq	Water	
	Output	Emission	Sb-125	2.82E-07			kBq	Air	
	Output	Emission	SO2	58.29			kg	Air	
	Output	Emission	Sr-90	0.00738			kBq	Air	
	Output	Emission	Sr-90	8.94E-01			kBq	Water	
	Output	Emission	Suspended solids	55.621			kg	Water	
	Output	Emission	Tc-99	0.469			kBq	Water	
	Output	Emission	Tc-99	3.13E-07			kBq	Air	
	Output	Emission	Tetrachloromethane	2.13E-05			kg	Air	
	Output	Emission	Tetrafluoromethane	0.00152			kg	Air	
	Output	Emission	Th-230	0.0498			kBq	Air	
	Output	Emission	Th-230	13			kBq	Water	
	Output	Emission	Th-232	0.00873			kBq	Air	
	Output	Emission	Th-232	0.0129			kBq	Water	
Notes: Summation of dissolved organic carbon, fat acids as C, volatile organic compounds as C, TOC.	Output	Emission	Total organic carbon	1.45E+01			kg	Water	
	Output	Emission	Tributyl tin	1.25E-04			kg	Water	
	Output	Emission	Trichloromethane	8.72E-07			kg	Air	
	Output	Emission	U-234	0.0536			kBq	Air	
	Output	Emission	U-234	0.111			kBq	Water	
	Output	Emission	U-235	0.0026			kBq	Air	
	Output	Emission	U-235	0.165			kBq	Water	
	Output	Emission	U-238	0.0778			kBq	Air	
	Output	Emission	U-238	0.281			kBq	Water	
	Output	Emission	V	9.63E-03			kg	Air	
	Output	Emission	V	9.81E-02			kg	Water	
	Output	Emission	Vinyl chloride	5.37E-06			kg	Air	
	Output	Emission	Xe-133	497			kBq	Air	
	Output	Emission	Zn	1.48E-02			kg	Air	
	Output	Emission	Zn	1.69E-02			kg	Ground	
	Output	Emission	Zn	2.21E-01			kg	Water	
	Output	Product	Electricity	1			TJ	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) and processing of hazardous waste is included.	Output	Residue	Hazardous waste	2.23E+00			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Highly radioactive waste	3.13E-06			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, no emissions from landfill assumed. Inert waste deposit is waste at landfill that are inert.	Output	Residue	Inert waste deposit	4.66E+03			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Low radioactive waste	2.71E-04			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Medium and low radioactive waste	3.83E-05			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from landfill. Reactive waste deposit is waste at landfill that is still reactive.	Output	Residue	Reactive waste deposit	3.62E+02			kg	Technosphere	
Notes: Internal flow! Infrastructure of spreading vehicles and emissions are included. Land farming is a treatment of organic sludge, the sludge is spread on a piece of land and left to degrade. Sometimes plants are grown on	Output	Residue	Waste in land farming	1.17E+02			kg	Technosphere	

the land, but those plants are destroyed.									
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from incineration plant.	Output	Residue	Waste to incineration	8.73E-01			kg	Technosphere	

About Inventory	
Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www. energieforschung.ch -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their lifecycles. The results can be used in lifecycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans. Vattenfalls purpose - as a commissioner of putting ETH:s data into Spine format with metadata - is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines. Data is supposed to be used together with IEA statistics about electricity generation mixes in the OECD countries/regions.
Detailed Purpose	ETH:s aim was to describe the average situation in Europe concerning electricity generation with fuel gas (a mix of natural gas, coke oven gas and blast furnace gas). With the help of assumptions and simplifications following phases of the life cycle are described: exploration (on- and offshore) extraction (on- and offshore), processing, long-distance transports, distribution and power plant.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Data reported here is supposed to be representative for fuel gas (natural gas, coke oven gas and blas furnace gas) electricity generation in the UCPTE countries in 1994. This set of data is aggregated and documented in accordance with the Swedish EPD-guidelines to be used in combination with IEA statistics concerning electricity generation mixes in OECD countries and regions together with other datasets - based on the ETH study - describing other power generation systems. The EPD-adapted power generation systems in Spine format are named as follows: Fuel gas electricity energy system, EPD-version Biofuel electricity energy system, EPD-version Hydro electricity energy system, EPD-version Lignite electricity energy system, EPD-version Nuclear electricity energy system, EPD-version Stone coal electricity energy system, EPD-version Wind electricity energy system, EPD-version IEA statistics for generation mixes 1998 exist in Spine format for the following 30 countries/regions: OECD total OECD North America OECD Pacific OECD Europe European Union Australia Austria Belgium Canada Czech Rpublic Denmark Finland France Germany Greece

	Hungary Iceland Ireland Italy Japan Korea Luxembourg Mexico Netherlands New Zealand Norway Poland Portugal Spain Sweden Switzerland Turkey United Kingdom United States
About Data	Reliability of data put into this lifecycle study: More reliable share of on- and offshore extraction amounts of flaring (allocation betw. oil and gas assumed) energyware consump. in extraction and processing phase constr. of extraction and processing plants transportation concerning construction aggregation to the UCPTE-mix for power plants fuel gas mix (natural, coke oven and blast furn. gas) conventional emissions from power plant Less reliable drilling during exploration and extraction amounts and concentrations in intraformation water processing of gas (except energyware) cleaning of trace elements in proc. plant area use gas leakage in the former Soviet Union lifetime of pipelines average gas flows in pipelines fuel chain of Algerian natural gas especially LNG route emissions of N2O, NMVOC, CO Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum groug metals for which rather detailed LCI data are provided. Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of ETH:s data and metadata has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of aggregation of figures and of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. The technical committee of the Swedish Environmental Management Council - approval of method and aggregation of parameters Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the überarbeitung, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut -- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 6 June 2001: <<< Changes made by Ann-Christin Pålsson, CPM based on discussions with Caroline Setterwall, Vattenfall AB. Comments: The following changes has been made in the nomenclature for in- and outflows: Mangane in ore -> changed to: Manganese in ore CH4 -> changed to: Methane (to be in accordance with the nomenclature specified in CPM

	report 2000:2) CN -> changed to: CN- Stone coal -> changed to: Hard coal (to be in accordance with the nomenclature specified in CPM report 2000:2) Other metals -> changed to: Metals Explanations of nomenclature (inserted in Notes for the specific flows): - CN- is Cyanide ion - Reactive waste deposit is waste at landfill that is still reactive. - Inert waste deposit is waste at landfill that are inert. Additional clarifications: - Note that the flows of waste in the table of in- and outflows are internal flows, i.e. they do NOT cross the system boundaries. All waste handling processes is included in the study with respect to use of resources and emissions. - Radioactive waste is accounted for in cubic metres. The product specific requirements for electricity and district heating generation (PSR 1998:1) in the Swedish EPD system states that waste shall be accounted for in gram. However, no conversion factors were given in the study. There are also no general conversion factors that are commonly used.

SPINE LCI dataset: Fuel gas electricity energy system, ETH - full version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Fuel gas electricity energy system, ETH - full version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant istself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures come from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996. Brief description The phases inventoried in ETH's life cycle study of electricity generation with fuel gas (74,5% natural gas 36 MJ/m3, 6,9% coke oven gas 18 MJ/m3, 18,6% blast furnace gas 3,3 MJ/m3) are: exploration of natural gas, extraction (onshore and offshore), processing, long distance transport and storage, regional distribution and power plant operation. The average situation in the UCPTE* region in 1994 concerning the origin of the gas, compression and transport, processing (of gas with more or less sulphur content), distribution, power plant operation etc. is described. About 15% of the natural gas is extracted together with crude oil and 20% of natural gas used in the UCPTE is extracted offshore. Coke oven gas is produced in a cokery out of stone coal but is not described in detail in this documentation (see metadata in ''Stone coal electricity energy system, EPD-version'' and the original ETH study) but blast furnace gas is seen as a byproduct in steel production and is not charged with any environmental impact for its supply in this study. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle.

Detailed description

Exploration of natural gas
Drilling activities during exploration of natural gas have been inventoried regarding use of energyware, drilling chemicals, water, steel and concrete (coating of drilling holes) and use of land/sea bed. Besides emissions arising due to use of energyware also emissions of methane and other volatile organic compounds from the drilling holes are included. Natural gas/crude oil emanating in drilling test is burnt, emissions are included.
Offshore exploration leads to emissions of drilling chemicals and drilling sludge to the sea, though a lot of it is cleaned on the platform before it is emitted. Other emissions to the sea are heavy metals from the drilled sea bed, oil and intraformation water. Some of the drilling chemicals and sludge is brought to the shore as waste.
Waste of onshore activities are of the same kind. It is put in landfills, in land farming or casted (emissions from these processes are included).

Extraction of natural gas
Average on- and offshore extraction has been inventoried regarding construction and demolition of platforms, towers, pipelines etc., use of energyware, materials (steel and concrete) and land/sea bed.
A first processing step of natural gas to remove sulphur (for gases with a high sulphur content, H_2S > 1% by volume) is included as well as flaring of gas, leaks, blow-outs and low pressure venting (emissions of mercury and radioactive radon are accounted for since these elements are found in the gas).
Compression is used in the extracting process, for transportation to processing plant (onshore about 50 km) and for compensation of pressure losses in the processing plant. Gas turbines are used (10-20 MW) driven by not yet processed natural gas, raw gas.
Extraction of gas together with crude oil gives a higher energyware consumption than extraction of natural gas alone due to larger compression and processing need.
Production of production chemicals, for ex. anticorrosives, and drilling chemicals as well as emissions of those chemicals is included based on rough estimations.
Onshore, most of the intraformation water is assumed to be pumped into hollows deep in the ground the rest is led into a fresh water recipient. Offshore most of the intraformation water is emitted to the sea.
Shipping of supplies is included.
Production waste consists of scale i.e. mineral deposits in equipment and pipelines. Scale is low level radioactive.

Processing of natural gas
Processing implies removal of water and oil, higher hydrocarbons, sulphur (efficiency 98%), mercury and radon as well as gas drying. Processing of gas with a higher sulphur content is often done onshore and is supplied by grid electricity while gas with a low sulphur content often is processed in the field (supply by gas turbines). Construction phase and operation phase is included (also flaring and leaks). Processed gas has a lower heating value of 34.4 MJ/m3 (density 0.8 kg/m3, 70% methane, sulphur content 0,002 g/m3).

Long-distance transports of natural gas
The average transport situation has been scanned. Transport in pipeline implies compression of the gas in several compressor stations with several natural gas driven gas turbines (10-20 MW). The average natural gas flow varies with pipeline, 0,77-1 milion m3 per h. Average transport distances are 800 km from the Netherlands, 1500 km from Norway, 800 km from Germany, 2500 km from Algeria and 6000 km from the former Soviet Union. Leakage rates for Russian natural gas are 0,5% for gas production and 1,5% for long distance transportation to Europe. For long distance transportation from other countries, a leakage rate of 0.01% per 1000 km is applied.
Construction of pipelines and seasonal storages (about 10% /year of the gas is stored), leaks, condensate separators, incineration of condensate and inspection flights are included.
64% of imported gas from Algeria is liquified (LNG): 15% of this gas is consumed for cooling of the gas. Transport is done by ship. Construction of gas containers is included but not of the ships themselves. Leaks are included.

Regional distribution of natural gas
The regional distribution implies gauging stations and pressure reducing stations, no further compressor stations are needed since the pressure from the long distance pipelines is enough. The regional distribution is however charged by some compression work done in the long distance pipeline system (0,2% of gas transported in the regional distribution network). The average transportation distance is set to 100 km. Medium gas flow: 30,3 TJ/km. Inspections and leaks are included.

Power plant for fuel gas
Fuel gas power plants are mainly used as top load plants with a low medium load (20%). Operation time is about 1800 h/year and electric efficiency is 39%. Fuel mix has been calculated from national statistics (including natural gas, coke oven gas and blast furnace gas) and fuel used for heat production (3,3% of total amount fuel gas used in the UCPTE) has been substracted. Construction and demolition of a 100 MWe steam turbin power plant has been inventoried. Data concerning operation emissions, water use and wastes has been found in literature and in public statistics and has been adapted to the UCPTE fuel gas mix.

* Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries

Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Manufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the industrial revolution I Modified human impact larger than other species', low degree of cultivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of interest. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is different from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH.
Time Boundary	Most of statistic figures used are from 1990 to 1994. For the calulation of the UCPTE gas electricity, fuel use in Europe of the year 1993 has been used. Data concerning material, chemical and energyware use are partly older. Figures concerning other fuel extraction and processing represent an average of the early nineties. Descriptions and figures of different technical processes come from literature, contractors, public and private institutions and describe the situation of the late eighties. Electricity used during the lifecycle has been assumed to be a mix based on the average generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years). All processes, also those conducted in the past, have been assumed to use average technology of the early nineties. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Pipelines in the gas field 30 years Pipelines, long distance 50 years Pipelines, regional distribution 40 years Power plant 30 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	Most important supplier countries of natural gas in the UCPTE are the Netherlands (39%), the states of the former Soviet Union (22%), Algeria (11%), Norway (9%) and Germany (7%). The rest comes mainly from Italy, France and Denmark (these countries are not included in this study, approximated with German figures). Only the Swiss regional distribution net for natural gas has been inventoried as a whole. Resulting figures have been adapted to UCPTE* conditions. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following

	countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	Dismantling process of platforms is not included and the whole platform including drillhole mantelings and pipelines are assumed to be deposited, i.e. no recycling. Manufacture of needed chemicals in the processing plant for natural gas is neglected as well as the their transport. Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	Allocation of pipelines to the produced amount of gas is difficult. The total gas distribution network has been inventoried and related to the total amount of transported gas in 1994 assuming that this is representative. Allocation between natural gas and crude oil when extracted together has been conducted according to the lower heating value. Allocation between electricity and heat in fuel gas power plants has been done according to exergy. The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	The figures have been copied from the module ''Electricity from fuel gas power plant UCPTE-mix'' (Strom ab Brenngas-Kraftwerk UCPTE-Mix) in the Ökoinventare von Energiesystemen, ETH Zürich 1996.
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	Multiple flows are reported for several emissions to air. This is because that in the original study emissions to air have been reported in three categories, indicated by one of the letters below following the substance name. - m = mobile (emissions from vehicles) - p = process (process specific emissions as for instance methane emissions during coal mining) - s = stationary (emissions from stationary combustion plants) This categorisation has however not been documented in this specification in the SPINE format.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Area II-III	264			m2a	Ground	
	Input	Natural resource	Area III-IV	172			m2a	Ground	
	Input	Natural resource	Area II-IV	109			m2a	Ground	
	Input	Natural resource	Area IV-IV	0.161			m2a	Ground	
	Input	Natural resource	Area, sea bed II-III	1440			m2a	Ground	
	Input	Natural resource	Area, sea bed II-IV	148			m2a	Ground	
	Input	Natural resource	Barite	87.5			kg	Ground	

	Input	Natural resource	Bauxite	15.5			kg	Ground	
	Input	Natural resource	Bentonite	10.3			kg	Ground	
	Input	Natural resource	Chromium in ore	0.105			kg	Ground	
	Input	Natural resource	Clay	30.5			kg	Ground	
	Input	Natural resource	Copper in ore	4.39			kg	Ground	
	Input	Natural resource	Crude oil	1.26			tonne	Ground	
	Input	Natural resource	Gravel	491			kg	Ground	
	Input	Natural resource	Hydro energy	0.00134			TJ	Water	
	Input	Natural resource	Iron in ore	458			kg	Ground	
	Input	Natural resource	Lead in ore	0.0578			kg	Ground	
	Input	Natural resource	Lignite	265			kg	Ground	
	Input	Natural resource	Limestone	200			kg	Ground	
	Input	Natural resource	Manganese in ore	0.0576			kg	Ground	
	Input	Natural resource	Mine gas (methane)	109			kg	Ground	
	Input	Natural resource	Natural gas	58900			Nm3	Ground	
	Input	Natural resource	Natural gas	86.1			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.0483			kg	Ground	
	Input	Natural resource	Palladium in ore	0.000000313			kg	Ground	
	Input	Natural resource	Platinum in ore	0.000000354			kg	Ground	
	Input	Natural resource	Rhodium in ore	0.000000333			kg	Ground	
	Input	Natural resource	Rock salt	17			kg	Ground	
	Input	Natural resource	Sand	1390			kg	Ground	
	Input	Natural resource	Stone coal	12100			kg	Ground	
	Input	Natural resource	Turbine water amount	7030			m3	Water	
	Input	Natural resource	Uranium in ore	0.0183			kg	Ground	
	Input	Natural resource	Water	608000			kg	Ground	
	Input	Natural resource	Wood	0.104			tonne	Ground	
	Input	Natural resource	Working amount in water storages	29			m3a	Water	
	Input	Natural resource	Zinc in ore	0.0019			kg	Ground	
	Input	Refined resource	Cobalt	0.00000071			kg	Technosphere	
	Input	Refined resource	Molybdenum	0.000000459			kg	Technosphere	
	Input	Refined resource	Rhenium	0.000000286			kg	Technosphere	
	Input	Refined resource	Silver	0.00396			kg	Technosphere	
	Input	Refined resource	Tin	0.0022			kg	Technosphere	
	Output	Emission	1,1,1-Trichloroethane	5.32E-08			kg	Fresh water	
	Output	Emission	1,2-Dichloroethane	0.0000191			kg	Fresh water	
	Output	Emission	1,2-Dichloroethane	0.000033			kg	Air	
	Output	Emission	Acenaphthylene	0.0771			kg	Fresh water	
	Output	Emission	Acetaldehyde	0.00256			kg	Air	

	Output	Emission	Acetic acid	0.314			kg	Air	
	Output	Emission	Acetone	0.000475			kg	Air	
	Output	Emission	Acetylene	0.00959			kg	Air	
	Output	Emission	Acids	0.0732			kg	Fresh water	
	Output	Emission	Acroleine	0.000000242			kg	Air	
	Output	Emission	Ag	0.0000335			kg	Sea water	
	Output	Emission	Ag	0.0000339			kg	Fresh water	
	Output	Emission	Ag-110m	0.00000752			kBq	Air	
	Output	Emission	Ag-110m	0.0513			kBq	Fresh water	
	Output	Emission	Al	0.0000929			kg	Sea water	
	Output	Emission	Al	0.000175			kg	Air	
	Output	Emission	Al	0.0224			kg	Air	
	Output	Emission	Al	0.103			kg	Air	
	Output	Emission	Al	1.12			kg	Ground	
	Output	Emission	Al	19.7			kg	Fresh water	
	Output	Emission	Aldehydes	0.0000146			kg	Air	
	Output	Emission	Alkanes	0.00438			kg	Air	
	Output	Emission	Alkanes	0.00727			kg	Sea water	
	Output	Emission	Alkanes	0.00958			kg	Fresh water	
	Output	Emission	Alkanes	0.0247			kg	Air	
	Output	Emission	Alkenes	0.0000166			kg	Air	
	Output	Emission	Alkenes	0.000671			kg	Sea water	
	Output	Emission	Alkenes	0.000872			kg	Fresh water	
	Output	Emission	Alkenes	0.011			kg	Air	
	Output	Emission	Alpha radiator	0.00000608			kBq	Fresh water	
	Output	Emission	Am-241	0.000141			kBq	Air	
	Output	Emission	Am-241	0.0185			kBq	Sea water	
	Output	Emission	AOX	0.0000855			kg	Sea water	
	Output	Emission	AOX	0.000149			kg	Fresh water	
	Output	Emission	Ar-41	16.3			kBq	Air	
	Output	Emission	Aromates	0.00000166			kg	Air	
	Output	Emission	Aromates	0.000293			kg	Air	
	Output	Emission	Aromatics	0.00766			kg	Fresh water	
	Output	Emission	Aromatics	0.109			kg	Sea water	
	Output	Emission	As	0.0000175			kg	Air	
	Output	Emission	As	0.0000188			kg	Sea water	
	Output	Emission	As	0.000109			kg	Air	
	Output	Emission	As	0.000132			kg	Air	
	Output	Emission	As	0.000447			kg	Ground	
	Output	Emission	As	0.0393			kg	Fresh water	
	Output	Emission	B	0.000329			kg	Air	
	Output	Emission	B	0.000773			kg	Sea water	
	Output	Emission	B	0.00304			kg	Fresh water	
	Output	Emission	B	0.011			kg	Air	
	Output	Emission	Ba	0.000327			kg	Air	
	Output	Emission	Ba	0.00121			kg	Air	
	Output	Emission	Ba	0.14			kg	Sea water	
	Output	Emission	Ba	1.61			kg	Fresh water	
	Output	Emission	Ba-140	0.0000302			kBq	Air	
	Output	Emission	Ba-140	0.000107			kBq	Fresh water	
	Output	Emission	Barite	17.9			kg	Sea water	
	Output	Emission	Be	0.000000723			kg	Fresh water	
	Output	Emission	Be	0.00000411			kg	Air	
	Output	Emission	Be	0.0000134			kg	Air	
	Output	Emission	Benzaldehyde	0.000000126			kg	Air	
	Output	Emission	Benzene	0.0000501			kg	Air	
	Output	Emission	Benzene	0.00727			kg	Sea water	
	Output	Emission	Benzene	0.00977			kg	Fresh water	
	Output	Emission	Benzene	0.018			kg	Air	
	Output	Emission	Benzene	0.878			kg	Air	
	Output	Emission	Benzo(a)pyrene	0.000369			kg	Air	
	Output	Emission	Benzo(a)pyrene	7.82E-08			kg	Air	
	Output	Emission	BOD	0.00103			kg	Sea water	
	Output	Emission	BOD	0.0896			kg	Fresh water	
	Output	Emission	Br	0.0000736			kg	Air	

	Output	Emission	Br	0.00124			kg	Air	
	Output	Emission	Butane	0.624			kg	Air	
	Output	Emission	Butane	2.28			kg	Air	
	Output	Emission	Butene	0.00468			kg	Air	
	Output	Emission	C	3.36			kg	Ground	
	Output	Emission	C-14	0.939			kBq	Sea water	
	Output	Emission	C-14	11.4			kBq	Air	
	Output	Emission	Ca	0.000151			kg	Air	
	Output	Emission	Ca	0.0168			kg	Air	
	Output	Emission	Ca	0.0288			kg	Air	
	Output	Emission	Ca	2.25			kg	Sea water	
	Output	Emission	Ca	25.8			kg	Fresh water	
	Output	Emission	Ca	4.47			kg	Ground	
	Output	Emission	Cd	0.000000512			kg	Air	
	Output	Emission	Cd	0.00000262			kg	Ground	
	Output	Emission	Cd	0.0000354			kg	Sea water	
	Output	Emission	Cd	0.000105			kg	Air	
	Output	Emission	Cd	0.000181			kg	Air	
	Output	Emission	Cd	0.00115			kg	Fresh water	
	Output	Emission	Cd-109	0.000000618			kBq	Fresh water	
	Output	Emission	Ce-141	0.000000699			kBq	Air	
	Output	Emission	Ce-141	0.000016			kBq	Fresh water	
	Output	Emission	Ce-144	0.00000455			kBq	Fresh water	
	Output	Emission	Ce-144	0.0015			kBq	Air	
	Output	Emission	Ce-144	0.425			kBq	Sea water	
	Output	Emission	CFC-11	0.00000579			kg	Air	
	Output	Emission	CFC-114	0.000153			kg	Air	
	Output	Emission	CFC-12	0.00000125			kg	Air	
	Output	Emission	CFC-13	0.000000782			kg	Air	
	Output	Emission	CH4	0.0097			kg	Air	
	Output	Emission	CH4	3.71			kg	Air	
	Output	Emission	CH4	370			kg	Air	
	Output	Emission	Chlorinated solvents	0.0000502			kg	Fresh water	
	Output	Emission	Chlorobenzenes	1.92E-09			kg	Fresh water	
	Output	Emission	Cl-	149			kg	Fresh water	
	Output	Emission	Cl-	28.9			kg	Sea water	
	Output	Emission	ClO-	0.000576			kg	Sea water	
	Output	Emission	ClO-	0.0024			kg	Fresh water	
	Output	Emission	Cm alpha	0.000223			kBq	Air	
	Output	Emission	Cm alpha	0.0246			kBq	Sea water	
	Output	Emission	Cm-242	7.38E-10			kBq	Air	
	Output	Emission	Cm-244	6.7E-09			kBq	Air	
	Output	Emission	CN	0.000636			kg	Air	
	Output	Emission	CN	3.08E-11			kg	Air	
	Output	Emission	CN-	0.0000929			kg	Sea water	
	Output	Emission	CN-	0.0164			kg	Fresh water	
	Output	Emission	Co	0.00000172			kg	Ground	
	Output	Emission	Co	0.0000109			kg	Air	
	Output	Emission	Co	0.0000694			kg	Air	
	Output	Emission	Co	0.000195			kg	Air	
	Output	Emission	Co	0.0392			kg	Fresh water	
	Output	Emission	CO	0.253			kg	Air	
	Output	Emission	CO	5.62			kg	Air	
	Output	Emission	CO	76.1			kg	Air	
	Output	Emission	CO2	125			kg	Air	
	Output	Emission	CO2	245000			kg	Air	
	Output	Emission	CO2	706			kg	Air	
	Output	Emission	Co-57	0.00011			kBq	Fresh water	
	Output	Emission	Co-57	1.29E-08			kBq	Air	
	Output	Emission	Co-58	0.000213			kBq	Air	
	Output	Emission	Co-58	0.0854			kBq	Fresh water	
	Output	Emission	Co-60	0.000319			kBq	Air	
	Output	Emission	Co-60	0.0914			kBq	Fresh water	
	Output	Emission	Co-60	4.02			kBq	Sea water	
	Output	Emission	COD	0.0237			kg	Sea water	

	Output	Emission	COD	0.854			kg	Fresh water	
	Output	Emission	Cr	0.00000864			kg	Air	
	Output	Emission	Cr	0.000178			kg	Air	
	Output	Emission	Cr	0.000625			kg	Air	
	Output	Emission	Cr	0.00559			kg	Ground	
	Output	Emission	Cr(VI)	0.00000105			kg	Fresh water	
	Output	Emission	Cr3+	0.00566			kg	Sea water	
	Output	Emission	Cr3+	0.198			kg	Fresh water	
	Output	Emission	Cr-51	0.0000265			kBq	Air	
	Output	Emission	Cr-51	0.00235			kBq	Fresh water	
	Output	Emission	Cs	0.00000707			kg	Fresh water	
	Output	Emission	Cs	0.0000559			kg	Sea water	
	Output	Emission	Cs-134	0.00535			kBq	Air	
	Output	Emission	Cs-134	0.0107			kBq	Fresh water	
	Output	Emission	Cs-134	0.939			kBq	Sea water	
	Output	Emission	Cs-136	0.000000574			kBq	Fresh water	
	Output	Emission	Cs-137	0.0103			kBq	Air	
	Output	Emission	Cs-137	0.0252			kBq	Fresh water	
	Output	Emission	Cs-137	8.72			kBq	Sea water	
	Output	Emission	Cu	0.00000858			kg	Ground	
	Output	Emission	Cu	0.0000783			kg	Sea water	
	Output	Emission	Cu	0.000245			kg	Air	
	Output	Emission	Cu	0.000968			kg	Air	
	Output	Emission	Cu	0.00167			kg	Air	
	Output	Emission	Cu	0.0999			kg	Fresh water	
	Output	Emission	Di-(2-ethylhexyl) phthalate	1.9E-09			kg	Fresh water	
	Output	Emission	Dibutyl p-phthalate	0.0000078			kg	Fresh water	
	Output	Emission	Dichloromethane	0.0000815			kg	Air	
	Output	Emission	Dichloromethane	0.00776			kg	Fresh water	
	Output	Emission	Different beta	0.00000106			kBq	Air	
	Output	Emission	Dimethyl p-phthalate	0.0000491			kg	Fresh water	
	Output	Emission	Dioxin (TCDD)	1480			ng	Air	
	Output	Emission	Dissolved organic carbon	0.192			kg	Sea water	
	Output	Emission	Dissolved organic carbon	0.677			kg	Fresh water	
	Output	Emission	Dissolved solids	0.38			kg	Sea water	
	Output	Emission	Dissolved solids	7.32			kg	Fresh water	
	Output	Emission	Ethane	0.093			kg	Air	
	Output	Emission	Ethane	9.53			kg	Air	
	Output	Emission	Ethanol	0.00000376			kg	Air	
	Output	Emission	Ethanol	0.000949			kg	Air	
	Output	Emission	Ethene	0.0837			kg	Air	
	Output	Emission	Ethene	0.284			kg	Air	
	Output	Emission	Ethylbenzene	0.000168			kg	Fresh water	
	Output	Emission	Ethylbenzene	0.00116			kg	Air	
	Output	Emission	Ethylbenzene	0.00134			kg	Sea water	
	Output	Emission	Ethylbenzene	0.00228			kg	Air	
	Output	Emission	F-	0.000559			kg	Sea water	
	Output	Emission	F-	0.196			kg	Fresh water	
	Output	Emission	Fe	0.000333			kg	Air	
	Output	Emission	Fe	0.00653			kg	Sea water	
	Output	Emission	Fe	0.0129			kg	Air	
	Output	Emission	Fe	0.069			kg	Air	
	Output	Emission	Fe	2.24			kg	Ground	
	Output	Emission	Fe	6.67			kg	Fresh water	
	Output	Emission	Fe-59	0.000000292			kBq	Air	
	Output	Emission	Fe-59	0.00000189			kBq	Fresh water	
	Output	Emission	Fission and rad. prod.	0.0552			kBq	Fresh water	
	Output	Emission	Formaldehyde	0.000017			kg	Fresh water	
	Output	Emission	Formaldehyde	0.000281			kg	Air	
	Output	Emission	Formaldehyde	2.08			kg	Air	
	Output	Emission	Glutaraldehyde	0.00221			kg	Sea water	
	Output	Emission	H-1301	0.000488			kg	Air	
	Output	Emission	H2S	0.0149			kg	Fresh water	
	Output	Emission	H2S	0.275			kg	Air	
	Output	Emission	H2S	0.827			kg	Air	

	Output	Emission	H-3	116			kBq	Air	
	Output	Emission	H-3	26800			kBq	Sea water	
	Output	Emission	H-3	986			kBq	Fresh water	
	Output	Emission	HCFC-21	0.000792			kg	Air	
	Output	Emission	HCFC-22	0.00000138			kg	Air	
	Output	Emission	HCl	0.0175			kg	Air	
	Output	Emission	HCl	0.204			kg	Air	
	Output	Emission	He	0.0113			kg	Air	
	Output	Emission	He	0.0755			kg	Air	
	Output	Emission	Heat	0.0000546			TJ	Ground	
	Output	Emission	Heat	0.000188			TJ	Sea water	
	Output	Emission	Heat	0.000512			TJ	Fresh water	
	Output	Emission	Heat	0.00186			TJ	Air	
	Output	Emission	Heat	0.0158			TJ	Air	
	Output	Emission	Heat	2.08			TJ	Air	
	Output	Emission	Heptane	0.0228			kg	Air	
	Output	Emission	Hexachlorobenzene	9.53E-10			kg	Air	
	Output	Emission	Hexachloroethane	3.77E-10			kg	Fresh water	
	Output	Emission	Hexafluoroethane	0.000169			kg	Air	
	Output	Emission	Hexane	0.0479			kg	Air	
	Output	Emission	HF	0.00565			kg	Air	
	Output	Emission	HF	0.0226			kg	Air	
	Output	Emission	HFC-134a	-2.85E-15			kg	Air	
	Output	Emission	Hg	0.000000508			kg	Air	
	Output	Emission	Hg	0.00000107			kg	Ground	
	Output	Emission	Hg	0.0000424			kg	Sea water	
	Output	Emission	Hg	0.000183			kg	Fresh water	
	Output	Emission	Hg	0.00021			kg	Air	
	Output	Emission	Hg	0.000537			kg	Air	
	Output	Emission	HOCl	0.000576			kg	Sea water	
	Output	Emission	HOCl	0.0024			kg	Fresh water	
	Output	Emission	Hydrocarbons	0.000184			kg	Fresh water	
	Output	Emission	I	0.0000185			kg	Air	
	Output	Emission	I	0.000518			kg	Air	
	Output	Emission	I	0.000699			kg	Fresh water	
	Output	Emission	I	0.00559			kg	Sea water	
	Output	Emission	I-129	0.0402			kBq	Air	
	Output	Emission	I-129	2.68			kBq	Sea water	
	Output	Emission	I-131	0.00183			kBq	Fresh water	
	Output	Emission	I-131	0.0047			kBq	Air	
	Output	Emission	I-133	0.000489			kBq	Fresh water	
	Output	Emission	I-133	0.00249			kBq	Air	
	Output	Emission	I-135	0.00372			kBq	Air	
	Output	Emission	K	0.00282			kg	Air	
	Output	Emission	K	0.0904			kg	Air	
	Output	Emission	K	0.26			kg	Sea water	
	Output	Emission	K	6.07			kg	Fresh water	
	Output	Emission	K-40	0.0329			kBq	Air	
	Output	Emission	K-40	0.0693			kBq	Fresh water	
	Output	Emission	Kr-85	693000			kBq	Air	
	Output	Emission	Kr-85m	0.896			kBq	Air	
	Output	Emission	Kr-87	0.389			kBq	Air	
	Output	Emission	Kr-88	32.5			kBq	Air	
	Output	Emission	Kr-89	0.281			kBq	Air	
	Output	Emission	La	0.00000903			kg	Air	
	Output	Emission	La	0.0000603			kg	Air	
	Output	Emission	La-140	0.0000187			kBq	Air	
	Output	Emission	La-140	0.0000222			kBq	Fresh water	
	Output	Emission	Methanol	0.00107			kg	Air	
	Output	Emission	Methyl Tertiary Butyl Ether	0.000000136			kg	Sea water	
	Output	Emission	Methyl Tertiary Butyl Ether	0.000000243			kg	Fresh water	
	Output	Emission	Methyl Tertiary Butyl Ether	0.00000428			kg	Air	
	Output	Emission	Mg	0.00788			kg	Air	
	Output	Emission	Mg	0.0371			kg	Sea water	
	Output	Emission	Mg	0.0378			kg	Air	

	Output	Emission	Mg	15.8			kg	Fresh water	
	Output	Emission	Mn	0.000151			kg	Air	
	Output	Emission	Mn	0.00337			kg	Sea water	
	Output	Emission	Mn	0.0214			kg	Air	
	Output	Emission	Mn	0.0447			kg	Ground	
	Output	Emission	Mn	0.403			kg	Fresh water	
	Output	Emission	Mn-54	0.00000765			kBq	Air	
	Output	Emission	Mn-54	0.004			kBq	Fresh water	
	Output	Emission	Mn-54	0.626			kBq	Sea water	
	Output	Emission	Mo	0.000014			kg	Air	
	Output	Emission	Mo	0.0000179			kg	Air	
	Output	Emission	Mo	0.0000186			kg	Sea water	
	Output	Emission	Mo	0.000067			kg	Air	
	Output	Emission	Mo	0.0495			kg	Fresh water	
	Output	Emission	Mo-99	0.00000748			kBq	Fresh water	
	Output	Emission	N	0.000918			kg	Ground	
	Output	Emission	N total	0.0291			kg	Sea water	
	Output	Emission	N total	0.0529			kg	Fresh water	
	Output	Emission	N2	15.9			kg	Air	
	Output	Emission	N2O	0.00509			kg	Air	
	Output	Emission	N2O	0.0318			kg	Air	
	Output	Emission	N2O	1.46			kg	Air	
	Output	Emission	Na	0.000888			kg	Air	
	Output	Emission	Na	0.0042			kg	Air	
	Output	Emission	Na	0.00603			kg	Air	
	Output	Emission	Na	18.6			kg	Sea water	
	Output	Emission	Na	26.5			kg	Fresh water	
	Output	Emission	Na-24	0.00329			kBq	Fresh water	
	Output	Emission	Nb-95	0.00000135			kBq	Air	
	Output	Emission	Nb-95	0.0000607			kBq	Fresh water	
	Output	Emission	NH3	0.0229			kg	Air	
	Output	Emission	NH3	0.0372			kg	Air	
	Output	Emission	NH4+ as N	0.0218			kg	Sea water	
	Output	Emission	NH4+ as N	0.157			kg	Fresh water	
	Output	Emission	Ni	0.0000129			kg	Ground	
	Output	Emission	Ni	0.000132			kg	Sea water	
	Output	Emission	Ni	0.000864			kg	Air	
	Output	Emission	Ni	0.00191			kg	Air	
	Output	Emission	Ni	0.00298			kg	Air	
	Output	Emission	Ni	0.0992			kg	Fresh water	
	Output	Emission	NMVOC	0.0962			kg	Air	
	Output	Emission	NMVOC	1.57			kg	Air	
	Output	Emission	NMVOC	36.6			kg	Air	
	Output	Emission	NO2-	0.00036			kg	Fresh water	
	Output	Emission	NO2-	0.000715			kg	Sea water	
	Output	Emission	NO3-	0.0153			kg	Sea water	
	Output	Emission	NO3-	0.0746			kg	Fresh water	
	Output	Emission	Noble gases (radioactive)	1.13			kBq	Air	
	Output	Emission	NOx	1.46			kg	Air	
	Output	Emission	NOx	3.98			kg	Air	
	Output	Emission	NOx	403			kg	Air	
	Output	Emission	Np-237	0.00118			kBq	Sea water	
	Output	Emission	Np-237	7.38E-09			kBq	Air	
	Output	Emission	Nuclide mix	0.0000404			kBq	Fresh water	
	Output	Emission	Oil	0.00164			kg	Ground	
	Output	Emission	Oil	0.345			kg	Fresh water	
	Output	Emission	Oil	2.56			kg	Sea water	
	Output	Emission	Organic N	0.0034			kg	Sea water	
	Output	Emission	Organic N	0.00599			kg	Fresh water	
	Output	Emission	P	0.000102			kg	Air	
	Output	Emission	P	0.000281			kg	Air	
	Output	Emission	P	0.000606			kg	Air	
	Output	Emission	P	0.0569			kg	Ground	
	Output	Emission	P	0.0606			kg	Ground	
	Output	Emission	Pa-234m	0.00447			kBq	Air	

	Output	Emission	Pa-234m	0.0828			kBq	Fresh water	
	Output	Emission	PAH	0.00000107			kg	Air	
	Output	Emission	PAH	0.000286			kg	Fresh water	
	Output	Emission	PAH	0.000727			kg	Sea water	
	Output	Emission	PAH	0.0212			kg	Air	
	Output	Emission	Particles	0.0941			kg	Air	
	Output	Emission	Particles	12.8			kg	Air	
	Output	Emission	Particles	3.24			kg	Air	
	Output	Emission	Pb	0.0000194			kg	Sea water	
	Output	Emission	Pb	0.0000404			kg	Ground	
	Output	Emission	Pb	0.00103			kg	Air	
	Output	Emission	Pb	0.0014			kg	Air	
	Output	Emission	Pb	0.00162			kg	Air	
	Output	Emission	Pb	0.107			kg	Fresh water	
	Output	Emission	Pb-210	0.0498			kBq	Air	
	Output	Emission	Pb-210	0.0552			kBq	Fresh water	
	Output	Emission	Pb-210	0.117			kBq	Air	
	Output	Emission	Pentachlorobenzene	2.55E-09			kg	Air	
	Output	Emission	Pentachlorophenol	4.11E-10			kg	Air	
	Output	Emission	Pentane	0.121			kg	Air	
	Output	Emission	Pentane	3.32			kg	Air	
	Output	Emission	Phenol	0.00103			kg	Air	
	Output	Emission	Phenol	0.00653			kg	Sea water	
	Output	Emission	Phenol	0.0119			kg	Fresh water	
	Output	Emission	Phosphoric compound	0.000629			kg	Fresh water	
	Output	Emission	Pm-147	0.0038			kBq	Air	
	Output	Emission	Po-210	0.0498			kBq	Air	
	Output	Emission	Po-210	0.0552			kBq	Fresh water	
	Output	Emission	Po-210	0.212			kBq	Air	
	Output	Emission	PO43-	0.000186			kg	Sea water	
	Output	Emission	PO43-	1.19			kg	Fresh water	
	Output	Emission	Propane	1.09			kg	Air	
	Output	Emission	Propane	2.41			kg	Air	
	Output	Emission	Propene	0.00553			kg	Air	
	Output	Emission	Propene	0.0188			kg	Air	
	Output	Emission	Propionic acid	0.0416			kg	Air	
	Output	Emission	Propionic aldehyde	0.000000126			kg	Air	
	Output	Emission	Pt	0.000000208			kg	Air	
	Output	Emission	Pu alpha	0.000447			kBq	Air	
	Output	Emission	Pu alpha	0.0738			kBq	Sea water	
	Output	Emission	Pu-238	1.67E-08			kBq	Air	
	Output	Emission	Pu-241 beta	0.0123			kBq	Air	
	Output	Emission	Pu-241 beta	1.83			kBq	Sea water	
	Output	Emission	Ra-224	0.349			kBq	Fresh water	
	Output	Emission	Ra-224	2.8			kBq	Sea water	
	Output	Emission	Ra-226	0.03			kBq	Air	
	Output	Emission	Ra-226	0.14			kBq	Air	
	Output	Emission	Ra-226	342			kBq	Fresh water	
	Output	Emission	Ra-226	5.59			kBq	Sea water	
	Output	Emission	Ra-228	0.0162			kBq	Air	
	Output	Emission	Ra-228	0.699			kBq	Fresh water	
	Output	Emission	Ra-228	5.59			kBq	Sea water	
	Output	Emission	Rb	0.0000706			kg	Fresh water	
	Output	Emission	Rb	0.000559			kg	Sea water	
	Output	Emission	Rn-220	1.17			kBq	Air	
	Output	Emission	Rn-222	11000			kBq	Air	
	Output	Emission	Rn-222	126			kBq	Air	
	Output	Emission	Rn-222 (long term)	995000			kBq	Air	
	Output	Emission	Ru-103	0.0000358			kBq	Fresh water	
	Output	Emission	Ru-103	7.75E-08			kBq	Air	
	Output	Emission	Ru-106	0.0447			kBq	Air	
	Output	Emission	Ru-106	4.47			kBq	Sea water	
	Output	Emission	S	0.671			kg	Ground	
	Output	Emission	S2-	0.000744			kg	Sea water	
	Output	Emission	S2-	0.00135			kg	Fresh water	

		Output	Emission	Salt	4.98			kg	Fresh water	
		Output	Emission	Sb	0.00000658			kg	Air	
		Output	Emission	Sb	0.0000146			kg	Air	
		Output	Emission	Sb	0.0000311			kg	Fresh water	
		Output	Emission	Sb-122	0.000107			kBq	Fresh water	
		Output	Emission	Sb-124	0.00000207			kBq	Air	
		Output	Emission	Sb-124	0.0134			kBq	Fresh water	
		Output	Emission	Sb-125	0.000000282			kBq	Air	
		Output	Emission	Sb-125	0.000872			kBq	Fresh water	
		Output	Emission	Sc	0.00000303			kg	Air	
		Output	Emission	Sc	0.0000238			kg	Air	
		Output	Emission	Se	0.00000508			kg	Air	
		Output	Emission	Se	0.0000194			kg	Sea water	
		Output	Emission	Se	0.000174			kg	Air	
		Output	Emission	Se	0.00127			kg	Air	
		Output	Emission	Se	0.098			kg	Fresh water	
		Output	Emission	Si	0.000151			kg	Air	
		Output	Emission	Si	0.00871			kg	Fresh water	
		Output	Emission	Si	0.0626			kg	Air	
		Output	Emission	Si	0.15			kg	Air	
		Output	Emission	Sn	0.00000364			kg	Fresh water	
		Output	Emission	Sn	0.00000534			kg	Air	
		Output	Emission	Sn	0.0000121			kg	Air	
		Output	Emission	SO2	1.89			kg	Air	
		Output	Emission	SO2	23.6			kg	Air	
		Output	Emission	SO2	32.8			kg	Air	
		Output	Emission	SO32-	0.000398			kg	Fresh water	
		Output	Emission	SO42-	0.56			kg	Sea water	
		Output	Emission	SO42-	111			kg	Fresh water	
		Output	Emission	Sr	0.000394			kg	Air	
		Output	Emission	Sr	0.00121			kg	Air	
		Output	Emission	Sr	0.279			kg	Fresh water	
		Output	Emission	Sr	0.337			kg	Sea water	
		Output	Emission	Sr-89	0.0000134			kBq	Air	
		Output	Emission	Sr-89	0.000242			kBq	Fresh water	
		Output	Emission	Sr-90	0.0000892			kBq	Fresh water	
		Output	Emission	Sr-90	0.00738			kBq	Air	
		Output	Emission	Sr-90	0.894			kBq	Sea water	
		Output	Emission	Suspended solids	0.321			kg	Fresh water	
		Output	Emission	Suspended solids	55.3			kg	Sea water	
		Output	Emission	Tc-99	0.000000313			kBq	Air	
		Output	Emission	Tc-99	0.469			kBq	Sea water	
		Output	Emission	Tc-99m	0.0000504			kBq	Fresh water	
		Output	Emission	Te-123	0.00000451			kBq	Fresh water	
		Output	Emission	Te-123m	0.0000335			kBq	Air	
		Output	Emission	Te-132	0.00000185			kBq	Fresh water	
		Output	Emission	Tetrachloroethene	4.48E-08			kg	Fresh water	
		Output	Emission	Tetrachloromethane	0.0000213			kg	Air	
		Output	Emission	Tetrachloromethane	6.83E-08			kg	Fresh water	
		Output	Emission	Tetrafluoromethane	0.00152			kg	Air	
		Output	Emission	Th	0.00000589			kg	Air	
		Output	Emission	Th	0.0000238			kg	Air	
		Output	Emission	Th-228	0.0137			kBq	Air	
		Output	Emission	Th-228	1.4			kBq	Fresh water	
		Output	Emission	Th-228	11.2			kBq	Sea water	
		Output	Emission	Th-230	0.0498			kBq	Air	
		Output	Emission	Th-230	13			kBq	Fresh water	
		Output	Emission	Th-232	0.00873			kBq	Air	
		Output	Emission	Th-232	0.0129			kBq	Fresh water	
		Output	Emission	Th-234	0.00447			kBq	Air	
		Output	Emission	Th-234	0.0835			kBq	Fresh water	
		Output	Emission	Ti	0.000926			kg	Air	
		Output	Emission	Ti	0.00366			kg	Air	
		Output	Emission	Ti	1.18			kg	Fresh water	
		Output	Emission	Tl	0.00000247			kg	Air	

	Output	Emission	Tl	0.00000603			kg	Air	
	Output	Emission	Toluene	0.00604			kg	Sea water	
	Output	Emission	Toluene	0.00875			kg	Fresh water	
	Output	Emission	Toluene	0.0142			kg	Air	
	Output	Emission	Toluene	0.426			kg	Air	
	Output	Emission	Total organic carbon	0.0341			kg	Fresh water	
	Output	Emission	Total organic carbon	0.461			kg	Sea water	
	Output	Emission	Total organic carbon	1.81			kg	Sea water	
	Output	Emission	Total organic carbon	11.3			kg	Fresh water	
	Output	Emission	Tributyltin	0.000125			kg	Sea water	
	Output	Emission	Trichloroethene	0.00000283			kg	Fresh water	
	Output	Emission	Trichloromethane	0.000000872			kg	Air	
	Output	Emission	Trichloromethane	0.0000104			kg	Fresh water	
	Output	Emission	Triethylene glycol	0.192			kg	Sea water	
	Output	Emission	Triethylene glycol	0.677			kg	Fresh water	
	Output	Emission	U	0.00000641			kg	Air	
	Output	Emission	U	0.0000121			kg	Air	
	Output	Emission	U alpha	0.0154			kBq	Sea water	
	Output	Emission	U alpha	0.16			kBq	Air	
	Output	Emission	U alpha	5.4			kBq	Fresh water	
	Output	Emission	U-234	0.0536			kBq	Air	
	Output	Emission	U-234	0.111			kBq	Fresh water	
	Output	Emission	U-235	0.0026			kBq	Air	
	Output	Emission	U-235	0.165			kBq	Fresh water	
	Output	Emission	U-238	0.025			kBq	Air	
	Output	Emission	U-238	0.0528			kBq	Air	
	Output	Emission	U-238	0.281			kBq	Fresh water	
	Output	Emission	V	0.0000186			kg	Sea water	
	Output	Emission	V	0.000293			kg	Air	
	Output	Emission	V	0.00229			kg	Air	
	Output	Emission	V	0.00705			kg	Air	
	Output	Emission	V	0.0981			kg	Fresh water	
	Output	Emission	W	0.0000242			kg	Fresh water	
	Output	Emission	Vinyl chloride	0.00000537			kg	Air	
	Output	Emission	Vinyl chloride	1.27E-08			kg	Fresh water	
	Output	Emission	VOC	0.00245			kg	Fresh water	
	Output	Emission	VOC	0.0196			kg	Sea water	
	Output	Emission	Xe-121m	1.79			kBq	Air	
	Output	Emission	Xe-133	497			kBq	Air	
	Output	Emission	Xe-133m	0.249			kBq	Air	
	Output	Emission	Xe-135	86.1			kBq	Air	
	Output	Emission	Xe-135m	9.09			kBq	Air	
	Output	Emission	Xe-137	0.222			kBq	Air	
	Output	Emission	Xe-138	2.47			kBq	Air	
	Output	Emission	Xylene	0.00526			kg	Sea water	
	Output	Emission	Xylene	0.007			kg	Fresh water	
	Output	Emission	Xylol	0.00519			kg	Air	
	Output	Emission	Xylol	0.0102			kg	Air	
	Output	Emission	Y-90	0.0000124			kBq	Fresh water	
	Output	Emission	Zn	0.000187			kg	Sea water	
	Output	Emission	Zn	0.0014			kg	Air	
	Output	Emission	Zn	0.00465			kg	Air	
	Output	Emission	Zn	0.00875			kg	Air	
	Output	Emission	Zn	0.0169			kg	Ground	
	Output	Emission	Zn	0.221			kg	Fresh water	
	Output	Emission	Zn-65	0.0000332			kBq	Air	
	Output	Emission	Zn-65	0.00696			kBq	Fresh water	
	Output	Emission	Zr	0.000293			kg	Air	
	Output	Emission	Zr-95	0.000000489			kBq	Air	
	Output	Emission	Zr-95	0.0000148			kBq	Fresh water	
	Output	Emission	Zr-95	0.038			kBq	Sea water	
	Output	Product	Electricity	1			TJ	Technosphere	
	Output	Residue	Hazardous waste	2.23			kg	Technosphere	
	Output	Residue	Highly radioactive waste	0.000271			kg	Technosphere	
	Output	Residue	Inert waste deposit	4660			kg	Technosphere	

	Output	Residue	Low radioactive waste	0.00000313			kg	Technosphere	
	Output	Residue	Medium and low radioactive waste	0.0000383			kg	Technosphere	
	Output	Residue	Reactive waste deposit	6.33			kg	Technosphere	
	Output	Residue	Waste deposit	356			kg	Technosphere	
	Output	Residue	Waste in land farming	117			kg	Technosphere	
	Output	Residue	Waste to incineration	0.873			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www. energieforschung.ch -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their lifecycles. The results can be used in lifecycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans.
Detailed Purpose	ETH:s aim was to describe the average situation in Europe concerning electricity generation with fuel gas (a mix of natural gas, coke oven gas and blast furnace gas). With the help of assumptions and simplifications following phases of the life cycle are described: exploration (on- and offshore) extraction (on- and offshore), processing, long-distance transports, distribution and power plant.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Reported figures are supposed to be representative for fuel gas (natural gas, coke oven gas and blast furnace gas) electricity generation in the UCPTE countries in 1994.
About Data	Reliability of data put into this lifecycle study: More reliable share of on- and offshore extraction amounts of flaring (allocation betw. oil and gas assumed) energyware consump. in extraction and processing phase constr. of extraction and processing plants transportation concerning construction aggregation to the UCPTE-mix for power plants fuel gas mix (natural, coke oven and blast furn. gas) conventional emissions from power plant Less reliable drilling during exploration and extraction amounts and concentrations in intraformation water processing of gas (except energyware) cleaning of trace elements in proc. plant area use gas leakage in the former Soviet Union lifetime of pipelines average gas flows in pipelines fuel chain of Algerian natural gas especially LNG route emissions of N2O, NMVOC, CO Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided. Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.

Notes	Reviewer of this specification of metadata describing the ETH study has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the überarbeitung, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut

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SPINE LCI dataset: Gas-turbine power plant with support systems

Administrative	
Finished	Y
Date Completed	1996-12-01
Copyright	
Availability	Public

Technical System	
Name	Gas-turbine power plant with support systems
Functional Unit	Net production of 1 kWh electricity
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the production of 1 kWh electricity.
Process Type	Cradle to gate
Site	
Sector	Grid electricity and district heat
Owner	
Technical system description	The studied system include *fuel production and operation and maintenance of a gas-turbine power plant.* To represent the electricity production of Vattenfall in gas-turbine power plants, a prospected gas turbine power plant constructed and located in a similar way as the gas turbine power plant in Slite, Gotland is studied. The power plant is assumed to operate on fuel oil 1 (Eo1) produced from crude oil from the Norwegian continental-shelf. The fuel has a sulphur content of 0,1 %. Vattenfall:s gas turbine plants are used as reserve power and primarily at transient needs. Production of materials, chemicals and electricty and transports, used in association with the fuel chain and the operation and maintenance of the plant are included. *The fuel production* include drilling and extraction of crude oil, maintenance and reinvestments of the oil platforms, transport to the refinery in Mongstad, Norway, where the oil is refined to fuel oil 1 and transport from the refinery to the power plant. Gas turbines generally operates on gasoil (lighter fractions of diesel oil and fuel oil 1 (Eo1)) with strict requirement on low metal content. The fuel is stored in cylindrical oil cisterns. Gas turbines can also operate on kerosene.

	Technical data for the studied plant Annual time of use (recalculated as operation time at full effect) (hours): 50 Supplied fuel effect (MW): 444 Electricity effect (net) (MW): 120 Assumed life-time (years): 60 Electricity production (net) during 60 years (TWh): 0,0360

System Boundaries	
Nature Boundary	The analysis starts with *extraction of crude oil.* All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The power plant are assumed to operate during 60 years.
Geographical Boundary	The power plant is located in a similar way as the power plant in Slite, Gotland. The fuel used in the plant are refined from crude oil from the Norwegian continental-shelf. The oil is transported by tanker to the refinery in Mongstad (Norway), and then as fuel oil 1 with tanker to the power plant.
Other Boundaries	The studied system includes *fuel production and operation and maintenance of a gas-turbine power plant.* Calculations of building and demolition of the plant has been performed but are not included in this system. ***Sub-systems included in the system:*** • Drilling and extraction of oil, and maintenance and reinvestments of the oil platforms. • Known use of chemicals are accounted for. In the cases where it was possible to obtain data, resource use and emissions for the manufacture are included. • Use of resources and emissions to air from production of the electricity that is used in the life cycles. • Production of oil for the studied manufacturing processes and transports • Transports and manufacture of materials for maintenance are included but neglected in the calculations, since they have a small contribution. • Transports in association with the operation of the power plant. ***Sub-systems excluded from the system:*** • No reinvestments are included since the plant only is used for reserve power. • Equipment after the power station transformer. • Prospecting for oil and building and demolition of plants and production platforms and tanker for transport from the oil field in Norway to Gotland. • Waste and rest products are transported to final waste. Operation and chemical and biological decomposing processes in the final waste have not been considered. • The risk of major accidents and rare breakdowns and environmental consequences from these • Work environment • Environmental loads caused by the operation personnel • Emissions at ordinary occurring operation disturbances have not been studied.

Allocations	The *50/50 method* has been applied throughout the calculations. The method is described in ''Nordic Guidelines on Life-Cycle Assessment'', Nord 1995:20, The Nordic Council, Stockholm. Crude oil for production of fuel to the plant are assumed to be extracted together with natural gas. Data were obtained from Kristin Keiserås Bakkane, Novatech a.s. ''Life Cycle Data for Norwegian Oil and Gas'', that were based on the production at Norwegian oil fields in 1991. An average value for the extracted energy oil (78,6%) and gas (21,3%) for the year in question were used. In reality the distribution between extracted energy for oil and gas respectively, varies. Data has been allocated according to the average value, *i.e. 78,6% of emissions and use of resources are allocated to the crude oil production.* Equipment, use of resources and emissions used only in association with the extraction of one energyware are allocated 100% to that. The oil is assumed to be refined in Mongstad, Norway. Data for production of fuel oil 1 have been obtained from Statoil. The allocation between the different products in the refinery are not known.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	An LCA calculation of fuel production and operation and maintenance for a gas-turbine power plant.
Literature Reference	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', in Swedish, Vattenfall AB
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Land use for the extraction of raw materials and final waste (deponi) are not included.	Input	Natural resource	Area	.000137			m2	Ground	
Notes:	Input	Natural resource	Coal	.000319			kWh	Other	
Notes: Fuel used for the operation of the plant.	Input	Natural resource	Heavy oil	3.890000			kWh	Ground	
Notes:	Input	Natural resource	Iron ore	.090700			g	Ground	
Notes:	Input	Natural resource	Natural gas	.035300			kWh	Other	
Notes:	Input	Refined resource	Bio fuel	0.000000229			kWh	Technosphere	
Notes: Electricity produced by nuclear power. For the production of 1 kWh electricity, 1,24 g uranium ore is used.	Input	Refined resource	Electricity	.000002			kWh	Technosphere	
Notes: Electricity produced by water power.	Input	Refined resource	Electricity	.005470			kWh	Technosphere	
Notes: Oil include oil, gasoline, diesel and lubricating oil	Input	Refined resource	Heavy oil	.160000			kWh	Technosphere	
Notes: There are data gaps for e.g. manufacture of copper and cement.	Output	Emission	CO	1.120000			g	Air	
Notes:	Output	Emission	CO2	1040.000000			g	Air	
Notes: There are data gaps for e.g. manufacture of copper and cement and combustion.	Output	Emission	HC	.614000			g	Air	
Notes:	Output	Emission	NOx	3.490000			g	Air	
Notes: There are data gaps for e.g. manufacture of copper, cement and lubricating oil.	Output	Emission	N-tot	.000001			g	Water	
Notes: There are data gaps for e.g. manufacture of lubricating oil.	Output	Emission	Particles	.066500			g	Air	
Notes:	Output	Emission	SO2	.853000			g	Air	
Notes:	Output	Product	Electricity	1.000000			kWh	Technosphere	

Notes: Includes rest products from fuel extraction and production of materials and chemicals, materials and materials to final waste (deponi).	Output	Residue	Other rest products	.267000			g	Technosphere	

About Inventory	
Publication	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology
Intended User	The data can be used as a basi
General Purpose	• The work with life-cycle analysis are expected to *contribute to a reinforcement and structuring* of the environmental work within Vattenfall, and a deeper knowledge on the use of resources and emissions to the environment. • An LCA can *facilitate a need for reliable data for electricity production.* Electricity is used in the manufacture of almost every product, and data from an LCA can be used when conducting an LCA on products. • An LCA can *facilitate a choice between different techniques* for future electricity production. • An LCA can also help to *choose the most effective alternatives* to reduce the consumption of resources and environmental influence of the current electricity production system. • It is also possible to *compare* the environmental load for different alternatives of electricity production.
Detailed Purpose	To obtain a *reliable basis* to be able to perform life-cycle analyses of different types of electricity use, and to identify opportunities for improvements in the existing system. To identify data gaps and areas where the knowledge are poor.
Commissioner	- Vattenfall Elproduktion .
Practitioner	- Vattenfall Energisystem AB: Britt-Marie Brännström-Norberg Ulrika Dethlefsen Roland Johansson Caroline Setterwall Sofie Tunbrant .
Reviewer	- Thomas Ekvall, Chalmers Industriteknik (CIT) Gunnar Lindfors, Institutet för Vatten- och Luftvårdsforskning (IVL) Göran Finnveden, Institutet för Vatten- och Luftvårdsforskning (IVL)
Applicability	The studied system includes fuel production and operation and maintenance of a gas-turbine power plant. The analysis are based on data from a plant that are chosen to make the analysis *representative* for the operation and maintenance of *Vattenfall:s gas-turbine power plants*. Vattenfall:s gas turbine plants are used as reserve power and primarily at transient needs. The data is reliable since a specific plant have been studied. The consequence is however that the result is primarily valid for the studied plant. Thoroughly reliable data for every power source, requires life cycle analyses for a large number of power plants for every power source. There are 12 gas turbine plants in Sweden. Transmission and distribution losses are not included. When the result is used to study different types of electricity use, these losses should be included. A rough estimate are that the distribution losses for a large industry customer are approximately 5% of the bought electricity, i.e. to obtain data for the use of electricity the data should be multiplied with 1,05. For an average household customer the transmission losses are approximately 10% of the bought electricity, i.e. the data should be multiplied with 1,10. The choice of *emission data* has a major influence on the result. This is determined at the permit consideration for a plant, and may vary between different plants and countries. The choice of combustion technique and fuel also influence the result. In recent years water injection have been introduced in some of Vattenfall:s gas turbines. Water injection reduces the NOx emissions but also the degree of efficiency for electricity production. Gas turbines can be operated on kerosene or fuel oil 1 (Eo1), where Eo1 oil gives higher emissions of sulphur. The calculated *emissions from Norwegian oil extraction*

are probably not representative for oil that will be extracted in a few years. The emissions of NO_x and CO_2 will be reduced. The emissions from the gas-turbines used for electricity production on the oil platforms will be reduced by installation of low-NO_x-burners. For some turbines the NO_x emissions are estimated to be reduced by 80%. To reduce CO_2 emissions, Norwegian authorities have introduced a CO_2-charge. Use of gas-turbines, with a higher degree of efficiency will reduce the CO_2-emissions. The new oil-field, Trollfältet, taken in use in 1995 will use electricity from the Norwegian power net, which will reduce local emissions on the platform.

The complete study include building, operation and maintenance, and demolition of the power plant and fuel production. When the data is used for energy production in a life cycle analysis of a product or a system, that do not require expansion of the electricity production system, it however reasonable only to include fuel production and operation and maintenance. The other phases of the life cycle are the same independent on the electricity production.

About Data

The studied plant is a *prospected gas turbine power plant fired with fuel oil 1*, produced from crude oil from the Norwegian continental-shelf. It is constructed and located in a similar way as the gas turbine power plant in Slite, Gotland.

Data for the use of resources and energy for operation of the power stations are specific for the studied plant. Relevant data for transports, extraction and production of metals and chemicals, and manufacture and work on important components were hard to obtain. Data from manufacturers and other reports and studies, primarily life cycle analyses have been used. Production of material and transports are considered with current technology. Swedish standard values have been used to calculate fuel use and emissions from transports. Transport distances are specific for the operation of the plant.

The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Data for *extraction of crude oil* were obtained from Kristin KeiserÕs Bakkane, Novatech a.s. "Life Cycle Data for Norwegian Oil and Gas", that were based on the production at Norwegian oil fields in 1991.

The following *emission factors* have been used to calculate the emissions from operation of the power plant. The emission factors are based on an average of the emissions from Vattenfall¦s existing gas-turbines.
NO_x: 220 mg/MJ fuel; 30,8 g/kWh electricity
SO_2: 48 mg/MJ fuel; 0,667 g/kWh electricity
CO: 77 mg/MJ fuel; 1,08 g/kWh electricity
Particles: 3,4 mg/MJ fuel; 0,047 g/kWh electricity
CO_2: 70400 mg/MJ fuel; 986 g/kWh electricity
HC: 4,0 mg/MJ fuel; 0,056 g/kWh electricity

For electricity used in the manufacture of materials and fuels, *average electricity* for the respective countries distributed on the different electricity production alternatives have been used. The following *degrees of efficiencies* have been used to calculate the fuel used in the electricity production. The values are standard values for existing power plants. New modern plants have often higher degrees of efficiencies. The values are calculated from the effective heat value in the used fuels and the energy content in the steam produced in a nuclear power plant.

- Coal condensing: 40%
- Oil condensing: 40%
- Natural gas condensing/combination: 40%
- Gas turbine: 25%
- Combined heat and power plant(irrespective of fuel) 30% (for electricity production)
  85% (total for electricity and heat production)
- Water power: are not recalculated, are accounted for as kWh electricity

	• Nuclear power: 33%, are however not recalculated, but accounted for as kWh electricity or gram natural uranium.
Notes	

SPINE LCI dataset: General Purpose Polystyrene (GPPS)

Administrative	
Finished	Y
Date Completed	1993
Copyright	
Availability	

Technical System	
Name	General Purpose Polystyrene (GPPS)
Functional Unit	1 kg GPPS (first ed.)
Functional Unit Explanation	
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Polystyrene is a versatile polymer resin used in a wide range of applications - especially in the packaging industry. It is sold in the three main domains : crystal or general purpose polystyrene, high impactpolystyrene and expandable polystyrene. The production of styrene monomer can be thought of as replacing one of the hydrgen atoms in ethylene by a benzene ring (C6H6). The monomer is then polymerised in a manner similar to the polyethylene. In practise, the production route from crude oil and natural gas is as shown in figure 11. Crude oil refining produces a fraction known as naphta which contains a mixture of low molecular weight, saturated hydrocarbons of various composition. This is converted into smaller group of unsaturated hydrocarbons by cracking. The resulting mixture is then separated into its constituent components by distillation producing principally ethylene (C2H4), propylene (C3H6), mixed butenes of general formula C4H8 and a number of other compounds which find uses elsewhere in the petrochemical plant either as feedstocks or fuels. Although benzene is usually present in small quantities in crude oil, its direct extraction is usually uneconomic. Benzene can also be produced from naphtha by a process known as catalytic reforming. It is assumed that 50% is derived from each source.

System Boundaries	
Nature Boundary	Air-, Water- emissions and wastes out of our system Resource, input to our system
Time Boundary	
Geographical Boundary	Europe
Other Boundaries	
Allocations	unspecified

Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	98/01/26
Data Type	Unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	An LCA calculation of fuel production and operation and maintenance for a gas-turbine power plant.
Literature Reference	Unspecified
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Bauxite	1800			mg	Technosphere	Europe
	Input	Refined resource	Electricity	4.72			MJ	Technosphere	Europe
	Input	Refined resource	Heavy oil	39.59			MJ	Technosphere	Europe
	Input	Refined resource	Iron ore	300			mg	Technosphere	Europe
	Input	Refined resource	Limestone	200			mg	Technosphere	Europe
	Input	Refined resource	NaCl	14000			mg	Technosphere	Europe
	Input	Refined resource	Natural gas	57.07			MJ	Technosphere	Europe
	Input	Refined resource	Soil and loose earth material	20			mg	Technosphere	Europe
	Input	Refined resource	Water	5000000			mg	Technosphere	Europe
	Output	Emission	Acidification eq	200			mg	Water	Europe
	Output	Emission	BOD	80			mg	Water	Europe
	Output	Emission	Chlorides	500			mg	Water	Europe
	Output	Emission	CO	1400			mg	Air	Europe
	Output	Emission	CO2	1600000			mg	Air	Europe
	Output	Emission	COD	1800			mg	Water	Europe
	Output	Emission	Dissolved organics	50			mg	Water	Europe
	Output	Emission	Dissolved solids	500			mg	Water	Europe
	Output	emission	H2S	2			mg	Air	Europe
	Output	Emission	HC	26000			mg	Air	Europe
	Output	Emission	HC	500			mg	Water	Europe
	Output	emission	HCl	40			mg	Air	Europe
	Output	emission	HF	1			mg	Air	Europe
	Output	Emission	Metals	10			mg	Air	Europe
	Output	Emission	Metals	1100			mg	Water	Europe
	Output	Emission	NH3	10			mg	Water	Europe
	Output	emission	NOx	24000			mg	Air	Europe
Notes: The flow was denoted Other nitrogen in the report	Output	Emission	N-tot	20			mg	Water	Europe
	Output	Emission	Oil	200			mg	Water	Europe
	Output	Emission	Particles	3100			mg	Air	Europe
	Output	Emission	SOx	34000			mg	Air	Europe
	Output	Emission	Susp solids	1000			mg	Water	Europe
	Output	Product	PS	1			kg	Technosphere	Europe
	Output	Refined resource	Ferromanganese	0		1	mg	Technosphere	Europe
	Output	Residue	Ashes	5000			mg	Technosphere	Europe
	Output	Residue	Industrial waste	3000			mg	Technosphere	Europe
	Output	Residue	Mineral waste	14000			mg	Technosphere	Europe
	Output	Residue	Non-toxic chemicals	45000			mg	Technosphere	Europe

	Output	Residue	Toxic chemicals	0		1	mg	Technosphere	Europe

About Inventory	
Publication	Eco-profile of the European plastics industry Report 4 : Polystyrene APME 1993 (first edition) -- Data documented by: Sophie Louis, Volvo Technical Development Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	APME's eco-profiles serve two
General Purpose	There is an increasing demand concerning LCA data. Following this trend, APME members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of polystyrene
Commissioner	- APME, Avenue E. Van Nieuwenhuyse 4 Box 3 B-1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	
About Data	This set of data concerns the production of general purpose polystyrene (GPPS) supplied by ten 10 plants producing 700 000 tonnes of polymer yearly. All the input data are traced back to the extraction of raw materials.
Notes	

SPINE LCI dataset: General Purpose Polystyrene (GPPS)

Administrative	
Finished	Y
Date Completed	1997
Copyright	
Availability	

Technical System	
Name	General Purpose Polystyrene (GPPS)
Functional Unit	1 kg GPPS (second ed.)
Functional Unit Explanation	GPPS stands for General Purpose Polystyrene
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Polystyrene is a versatile polymer resin used in a wide range of applications - especially in the packaging industry. It is sold in the three main domains : crystal or general purpose polystyrene, high impactpolystyrene and expandable polystyrene. The production of styrene monomer can be thought of as replacing one of the hydrgen atoms in ethylene by a benzene ring (C6H6). The monomer is then polymerised in a manner similar to the polyethylene.

	In practise, the production route from crude oil and natural gas is as shown in figure 11. Crude oil refining produces a fraction known as naphta which contains a mixture of low molecular weight, saturated hydrocarbons of various composition. This is converted into smaller group of unsaturated hydrocarbons by cracking. The resulting mixture is then separated into its constituent components by distillation producing principally ethylene (C2H4), propylene (C3H6), mixed butenes of general formula C4H8 and a number of other compounds which find uses elsewhere in the petrochemical plant either as feedstocks or fuels. Although benzene is usually present in small quantities in crude oil, its direct extraction is usually uneconomic. Benzene can also be produced from naphtha by a process known as catalytic reforming. It is assumed that 50% is derived from each source.

System Boundaries

Nature Boundary	Air-, water emissions and wastes going out of our system Resource arriving into our system
Time Boundary	
Geographical Boundary	Europe
Other Boundaries	
Allocations	Unspecified
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	98/01/26
Data Type	Unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	Normal LCI method for the production of PR [from the cradle to the gate]
Literature Reference	(1) I. Boustead for the European Centre for Plastics in the Environment (PWMI). Eco profiles of the European plastics industry ; report 4 : PS . First Edition (2) H. Smith. Transactions of the world Energy Conference, 18, Section E. 1969. (3) Society of the Environmental Toxicology and Chemistry (SETAC). A technical Framework for Life Cycle Assessments. Washington DC, 1991. (4) International Standards Organisation 1996. Draft International Standard ISO/DIS 14040 : Environmental management - Life Cycöe Assessment - Principles and Framework (5) I. Boustead & GF Hancock. Handbook of industrial Energy Analysis. Ellis Horwood. Chichester/John Wiley, New-York. ISBN 0-85312-06401 (1979) (6) International Energy Agency. Electricity Information 1994. OECD/IEA, Paris,1995. (7) Energy World Year Book 1994. The Institute of Energy. London (8) I. Boustead. Ecoprofiles of the European plastics Industry. Report 2 : Olefin feedstock sources. A report for the European Centre for Plastics in the Environment (PWMI). Brussels, May 1993.
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Bauxite	960			mg	Technosphere	Europe
	Input	Refined resource	Calcium sulphate	16			mg	Technosphere	Europe
	Input	Refined resource	Electricity	3.87			MJ	Technosphere	Europe
	Input	Refined resource	Heavy oil	55.09			MJ	Technosphere	Europe
	Input	Refined resource	Iron ore	820			mg	Technosphere	Europe
	Input	Refined resource	Limestone	1300			mg	Technosphere	Europe
	Input	Refined resource	NaCl	1800			mg	Technosphere	Europe
	Input	Refined resource	Natural gas	27.32			MJ	Technosphere	Europe
	Input	Refined resource	SO2	17			mg	Technosphere	Europe
	Input	Refined resource	Soil and loose earth material	110			mg	Technosphere	Europe
	Input	Refined resource	Water	174800000			mg	Technosphere	Europe
	Output	Emission	Acidification eq	43			mg	Water	Europe
	Output	Emission	Aromatics	220			mg	Air	Europe
	Output	Emission	BOD	51			mg	Water	Europe
	Output	Emission	CH4	11000			mg	Air	Europe
	Output	Emission	Chlorides	5600			mg	Water	Europe
	Output	Emission	CO	1100			mg	Air	Europe
	Output	Emission	CO2	2600000			mg	Air	Europe

	Output	Emission	COD	370			mg	Water	Europe
	Output	Emission	Dissolved organics	31			mg	Water	Europe
	Output	Emission	Dissolved solids	110			mg	Water	Europe
	Output	Emission	H2	10			mg	Air	Europe
	Output	Emission	HC	2800			mg	Air	Europe
	Output	Emission	HC	92			mg	Water	Europe
	Output	Emission	HCl	26			mg	Air	Europe
	Output	Emission	Metals	430			mg	Water	Europe
	Output	Emission	Metals	9			mg	Air	Europe
	Output	Emission	Na+	490			mg	Water	Europe
	Output	Emission	NH3	9			mg	Water	Europe
	Output	Emission	NOx	12000			mg	Air	Europe
	Output	Emission	N-tot	7			mg	Water	Europe
	Output	Emission	Oil	69			mg	Water	Europe
	Output	Emission	Particles	1700			mg	Air	Europe
	Output	Emission	Phenol	5			mg	Water	Europe
	Output	Emission	Polycyclic HC	6			mg	Air	Europe
	Output	Emission	SOx	11000			mg	Air	Europe
	Output	Emission	Sulphates	160			mg	Water	Europe
	Output	Emission	Sulphur/sulphide	0			mg	Water	Europe
	Output	Emission	Susp solids	290			mg	Water	Europe
	Output	Product	PS	1			kg	Technosphere	Europe
	Output	Residue	Ashes	5000			mg	Technosphere	Europe
	Output	Residue	Building waste	29			mg	Technosphere	Europe
	Output	Residue	Industrial waste	1800			mg	Technosphere	Europe
	Output	Residue	Inert chemicals	0			mg	Technosphere	Europe
	Output	Residue	Metals	11			mg	Technosphere	Europe
	Output	Residue	Mineral waste	18000			mg	Technosphere	Europe
	Output	Residue	Other rest products	17			mg	Technosphere	Europe
	Output	Residue	Packaging	3			mg	Technosphere	Europe
	Output	Residue	Regulated chemicals	830			mg	Technosphere	Europe
	Output	Residue	To incinerate	3800			mg	Technosphere	Europe

About Inventory	
Publication	Eco profiles of the European plastics industry Report 4: Polystyrene (Second edition), 1997, APME Data documented by: Sophie Louis, Volvo Technical Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	APME's eco-profiles serve two
General Purpose	There is an increasing demand concerning LCA data. Following this trend, APME members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of GPPS
Commissioner	- APME, Avenue E. Van Nieuwenhuyse 4 Box 3 B-1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	
About Data	Data for the production of general purpose polystyrene is based on the production characteristics of 15 polymerisation operations producing a total of 810 000 tonnes of GPPS.
Notes	

SPINE LCI dataset: Germany, electricity generation mix 1998

Administrative

Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System

Name	Germany, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Germany
Sector	Energyware
Owner	Germany
Technical system description	The generation of electricity with different power generating systems in Germany during the year 1998.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	139402			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	160124			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	161644			GWh	Technosphere	

Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	17216			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	35			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	4600			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	54312			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	6376			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	8673			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	552382			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998

	OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Glassworks

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System	
Name	Glassworks
Functional Unit	1 kg
Functional Unit Explanation	1 kg of glass
Process Type	Gate to gate
Site	PLM AB, Limmared, Sweden
Sector	Consumer goods
Owner	PLM AB, Limmared, Sweden
Technical system description	PLM AB in Limmared produces both flint and amber glass. Glass is made mainly from the raw materials sand, soda, lime, dolomite and feldspar wich are fused at 1500-1600 degrees Celsius. It is a continous production process and the raw materials are constantly added, while the finished glass is taken out and cut into pieces suitable for the product which is shaped in the glass machine.

System Boundaries	
Nature Boundary	The observed nature boundary parameters are the emissions of NOx, SO2, CO2 and particulates to air and the emissions of suspended solids, oil and fat to water. Emissions from combustion (production) of electricity, LPG (Liquefied petrolium gas) and oil consumption are included. The emission factors for stationary installations of oil combustion is not included.
Time Boundary	
Geographical Boundary	The process takes place in Limmared, Sweden.
Other Boundaries	Observed parameters are electricity, LPG (Liquefied petrolium gas) and oil consumption. Further broken glass, sand, soda, lime, dolomite, feldspar and sodium sulphate come from the technosphere and glass go to the technosphere. No transports are included.

Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1991-01-01
Data Type	Derived, mixed
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	Literature study of an official governmental report, where a literature study and personal communication have been put together (Baumann et al.) The calculations of energyware and CO2 emissions are made by those who transformed the data set into SPINE-format.
Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden The literature study in the literature mentioned above is done from the permission according to the Swedish Environmental Protection Law for PLM AB, Limmared at The Board of County in Älvsborg, The Environmental control unit 1990 and Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990. Personal communication contact is Eriksson K J, PLM AB, Limmared, Sweden and Nyström E, Svensk glasåtervinning AB, Sweden.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: There is 1-2% moisture content in broken glass.	Input	Refined resource	Broken glass	366			g	Technosphere	
	Input	Refined resource	Dolomite	58			g	Technosphere	
Notes: This electricity is used for fans, assembly lines etc.	Input	Refined resource	Electricity	0.4			MJ	Technosphere	
Notes: For the melting process oil and electricity are needed in an amount of 1050-1150 kcal/tonne molten glass, depending on capacity utilisation. 7-8% of this is electrical energy. The figures are valid for the mix of 50% broken glass and 50% virgin raw material. A 2% energy saving is achived per 10% broken glass addad.	Input	Refined resource	Energyware		1.05	1.15	kcal	Technosphere	
	Input	Refined resource	Feldspar	43			g	Technosphere	
	Input	Refined resource	Lime	83			g	Technosphere	
Notes: LPG (Liquefied petrolium gas) is used at this rate irrespective of the amount of broken glass added in the melting process.	Input	Refined resource	LPG	0.564			MJ	Technosphere	
Notes: It is 5% moisture content in sand.	Input	Refined resource	Sand	76			g	Technosphere	
Notes: Soda is represented by 50% natural soda from the US and 50% Solvay soda.	Input	Refined resource	Soda	136			g	Technosphere	
	Input	Refined resource	Sodium sulphate	4			g	Technosphere	
Method: Carbon dioxide emissions are caused by the burning of oil and gas and by the release of gas from the melt. CO2 emissions in the form of melting losses amounts to approx. 170 g CO2/kg virgin raw material. Glass is made mainly from the raw materials sand (76 g), soda (136 g), lime (83 g), dolomite (58 g) and feldspar (43 g). Thus, the total amount of virgin raw material that is needed to produce 1 kg glass is 396 g. The carbon dioxide emissions are 170 g * 0,396 = 67,32 g. Notes: Carbon dioxide emissions are caused by the burning of oil and gas and	Output	Emission	CO2	67.32			g	Air	

by the release of gas from the melt. CO2 emissions in the form of melting losses amounts to approx. 170 g CO2/kg virgin raw material. The carbon dioxide emissions are also dependent on the proportion of broken glass added, because the consumption of fuel varies according to this amount.									
	Output	Emission	NOx	2.69			g	Air	
	Output	Emission	Oil and fat	0.009			g	Water	
	Output	Emission	Particulates	0.26			g	Air	
	Output	Emission	SO2	1.01			g	Air	
	Output	Emission	Susp solids	0.018			g	Water	
	Output	Product	Glass	1			kg	Technosphere	

About Inventory

Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden --- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology ---
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and use of packaging material.
Detailed Purpose	To calculate the energy need and emission for the following scenarios: (1) Glass produced from 100% virgin raw materials; waste to dump. (2) Glass produced from 30% virgin raw materials, that is 70% is recycled material; waste to dump. (3) Glass produced from 100% virgin raw materials, 97% is washed-up containers for recycling (thirteen times)
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	Glass containers can be refilled and this is done on a large scale in the case of beverage containers for beer, soft drinks and spirits. Glass can also be recovered from broken glass, wich is remelted. Uncoloured glass can only be made from uncoloured broken glass, while coloured glass can be produced from unsorted raw materials. --- The emission factors for stationary installations of oil combustion can be found under the activity ''Combustion of oil'' in this database.
About Data	It may be assumed that soda consist of 50% natural soda from the US and 50% Solvay soda. Melting losses occur in the form of carbon dioxide from lime and soda together with loss of water from sand and broken glass. There is 1-2% moisture content in broken glass and 5% moisture content in sand. For the melting process oil and electricity are needed in an amount of 1050-1150 kcal/tonne molten glass, depending on capacity utilisation. 7-8% of this is electrical energy. The figures are valid for the mix of 50% broken glass and 50% virgin raw material. A 2% energy saving is achived per 10% broken glass added. Irrespective of the amount of broken glass added, LPG is also used, plus electricity in general for fans, conveyor belts etc. Carbon dioxide emissions are caused by the burning of oil and gas and by the release of gas from the melt. CO2 emissions in the form of melting losses amounts to approx. 170 g CO2/kg virgin raw material. The carbon dioxide emissions are also dependent on the proportion of broken glass added, because the consumption of fuel varies according to this amount.
Notes	

SPINE LCI dataset: Glulam wood production

Administrative	
Finished	Y
Date Completed	1997-05-01
Copyright	
Availability	Public

Technical System	
Name	Glulam wood production
Functional Unit	kg
Functional Unit Explanation	1 kg of glulam wood
Process Type	Cradle to gate
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	This set of data includes Chemical industry, Glue factory, Forestry, Sawmill and Glulam factory (Hot pressing technique, High frequency gluing).

System Boundaries	
Nature Boundary	Extraction of chemicals used in the glue production is not included, but for the ones used to produce the packages.
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData	
Date Conceived	
Data Type	Unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	The average values are calculated from the environmental declarations of three Swedish production plants: Martinson Trä KB, Moelven Töreboda Limträ AB, Långshytte Trävaru AB (Trätek:1, 1996), (Trätek:2,1996), (Trätek:3,1996). The environmental declarations was preformed by Trätek, Stockholm.
Literature Reference	Trätek:1, 1996: Miljövarudeklaration nr 9608063, Limträ, Trätek, Stockholm, 1996 Trätek:2, 1996: Miljövarudeklaration nr 9608064, Limträ, Trätek, Stockholm, 1996 Trätek:3, 1996: Miljövarudeklaration nr 9608065, Limträ, Trätek, Stockholm, 1996 Methodology for Environmental Assessment of Wood Based Products, Version 2, Trätek (The Swedish Institute for Wood Technology Research), I Report, Stockholm, February, 1996
Notes	The data is collected during the spring 1997 but the sources are probably a year or a few years older. The data type unspecified implies that one do not know what the data is based on.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Bio fuel	4.03			MJ	Other	
	Input	Natural resource	Coal	0.00698			MJ	Other	
	Input	Natural resource	Coal	0.388			g	Other	
	Input	Natural resource	Coke	0.00171			MJ	Other	
	Input	Natural resource	Gas	0.29			MJ	Other	
	Input	Natural resource	Gas	16.3			g	Other	
	Input	Natural resource	Oil	0.0915			MJ	Other	
	Input	Natural resource	Round Timber	1240			g	Other	
	Input	Refined resource	Diesel	0.871			MJ	Other	
	Input	Refined resource	Electricity	2.07			MJ	Other	
	Output	Emission	BOD	0.00186			g	Water	
	Output	Emission	Chlorides	0.00171			g	Water	
	Output	Emission	CO	3.73			g	Air	
	Output	Emission	CO2	96.4			g	Air	
	Output	Emission	COD	0.0104			g	Water	
	Output	Emission	Dissolved solids	0.00163			g	Water	
	Output	Emission	HC	0.967			g	Air	
	Output	Emission	HCl	0.000163			g	Air	
	Output	Emission	NH3	0.0101			g	Air	
	Output	Emission	NOx	1.74			g	Air	
	Output	Emission	N-tot	0.000078			g	Water	
	Output	Emission	Oil (aq)	0.000233			g	Water	
	Output	Emission	Particles	0.481			g	Air	
	Output	Emission	SO2	0.258			g	Air	
	Output	Emission	Susp solids	0.000312			g	Water	
	Output	Emission	Urea	0.0101			g	Air	
Data type: Derived, unspecified Method: Recounted from m3 to kg. Notes: Glulam beam, L 40, contain: Wood 430 kg/m3 (dry substance) Glue (MUF or PRF) < 6 kg/m3 (dry substance) MUF= melamin-urea-formaldehyd PRF=fenol-resorcinol-formaldehyd The density of glulam wood is 430 kg/m3 (dry substance).	Output	Product	Glulam wood	1			kg	Technosphere	
	Output	Residue	Ashes	0.709			g	Other	
	Output	Residue	Cured glue	0.0628			g	Other	
	Output	Residue	Industrial waste	0.069			g	Other	
	Output	Residue	Mineral waste	0.247			g	Other	

About Inventory

Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund, Tillman; Report 1997:2; TEP; CTH; Göteborg; Sweden -- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology --
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural wooden and concrete frames in buildings during the whole life cycle, by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of wooden frames

Commissioner	- Finncement Finland .
Practitioner	Björklund Thomas, Tillman Anne-Marie - Technical Environmental Planning, CTH 412 96 Göteborg Sweden.
Reviewer	
Applicability	The function of the technical system is not sufficently described.
About Data	The average values are calculated from the environmental declarations of three Swedish production plants: Martinson Trä KB, Moelven Töreboda Limträ AB, Långshytte Trävaru AB. In the inventory of glue, additives like catalyst are not included. Environmental load from irrigation of timber is not included, neither the package industry.
Notes	--- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 12 June 2001 <<< Changes made by Ann-Christin Pålsson, based on the original report (Björklund et al.). Comments: - References to environmental declarations, that were used as basis for the data, is supplemented in Method and Notes in QMetaData. - A input flow of 'Feedstock energy' (18,2 MJ) in the flow table has been deleted due to that it represented the energy content of the product, and not a real physical flow. - A text in Applicability refererring to Trätek for further information about the data set has been deleted. - Flow type for Electricity and Diesel in the flow table have been changed from Natural resource to Refined resource.

SPINE LCI dataset: Greece, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Greece, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Greece
Sector	Energyware
Owner	Greece
Technical system description	The generation of electricity with different power generating systems in Greece during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.

Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	160			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	1713			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	32397			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	3717			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	45			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	70			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	8078			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	46180			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.

Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Grinding of bearing rollers

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System

Name	Grinding of bearing rollers
Functional Unit	One ground bearing roller: 9,2 kg
Functional Unit Explanation	One spherical roller bearing 232/530 consists of following components: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 bearing rollers (coated or non-coated) For the manufacturing of one bearing roller, one ground bearing roller is needed. The ground roller weighs 9,2 kg.
Process Type	Unit operation
Site	SKF Sverige AB415 50 GÖTEBORG
Sector	Materials and components
Owner	SKF Sverige AB415 50 GÖTEBORG
Technical system description	This activity is a subactivity of the system: ''Production of bearing rollers (à 9,2 kg)'' After the heat treatment the rollers are transported back to the E-factory and all sides of the rollers are ground and hand polished. This dataset includes the energy consumption for the grinding process of bearing rollers. The scrap from the grinding process is sent to Ovako Steel AB in Hofors by train. These activities are NOT included in this study, but in the complete data system: ''Production of bearing rollers à 9,2 kg)''. When the rollers have been hand polished they are ready for assembling and are mounted into the SKF spherical roller bearing 232/530.

System Boundaries

Nature Boundary	Emissions to air are not measured and could therefore not be reported in this study. Emissions to water and the use of cutting fluid at SKF, Göteborg, could according to allocation difficulties and lack of time not be calculated. The steel scrap from the grinding process at SKF, Göteborg, is sent to Ovako Steel in Hofors for recycling and is therefore not seen as waste, but a co-product to the technosphere. The grinding plates are not followed from the cradle and not to the grave because of lack of time. The inflow and outflow of grinding plates are therefore ending in the technosphere.
Time Boundary	The data was collected during the autumn 2002, and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The process is site specific for SKF in Göteborg, Sweden.
Other Boundaries	The electricity production is NOT included in this dataset, but must be accounted for to obtain the complete environmental impact. The impact from the production and disposal of the cutting fluid is not included in this dataset, since no data was available. The grinding plates could not be traced back to the cradle, since it was too time consuming.
Allocations	Energy consumption depends on how long the rollers is processed in the different process equipment. This varies according to weight, but also according to size and desired properties of the final product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	Data is gathered from interviews with Niclas Thim, SKF Large Bearings, Sweden.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.

Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Electricity	0.09171			kWh	Technosphere	
	Input	Refined resource	grinding plates	0.0004			m	Technosphere	
	Input	Refined resource	heat treated roller	11.44			kg	Technosphere	
	Output	Co-product	Steel scrap	2.24			kg	Technosphere	Sweden
	Output	Product	bearing roller	9.2			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valild for grinding of bearing rollers of the same material and weight and with the same processing equipment.
About Data	Data is gathered from interviews with Niclas Thim, SKF Large Bearings, Sweden.
Notes	

SPINE LCI dataset: Grinding of dolomite

Administrative

Finished	Y
Date Completed	99-01-25
Copyright	
Availability	Public

Technical System

Name	Grinding of dolomite
Functional Unit	1 kg ground dolomite
Functional Unit Explanation	
Process Type	Gate to gate
Site	Hydro Agri AB Box 516 SE-261 24 Landskrona Sweden
Sector	Materials and components

Owner	Hydro Agri AB Box 516 SE-261 24 Landskrona Sweden
Technical system description	The grinding takes place at the plant in Landskrona. The supply dolomite has a content of 12,5 % Mg.

System Boundaries

Nature Boundary	The system only includes grinding of dolomite, i.e production of electricity and extraction of dolomite is not included in this dataset.
Time Boundary	The data are figures for production in 1997.
Geographical Boundary	Hydro Agri AB in Landskrona, Sweden.
Other Boundaries	Emissions and use of resources due to the production of electricity is not included in this datset.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	An average value for emissions of particulates (dust) to air were given in mg/h and the assumed yearly operating time was 3000 h/year. Total emissions per year were then calculated and divided by total amounts of dolomite ground in 1997. Example: (35 400 mg particulates/h) * (3000 h/yr) / (34 000 ton dolomite/yr) = 3.12 g particulates/t dolomite Total amount of electricity consumed was divided by total amounts of dolomite ground in 1997. See also ''Specific QMetaData''.
Literature Reference	Miljörapport (official environmental report) 1997, Hydro Agri AB, Box 516, 261 24 Landskrona, Sweden. Personal communication: Ronnie Persson, Hydro Agri AB in Landskrona, tel: +46 418 76100.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: 12,5 % Mg	Input	Refined resource	Dolomite	1			kg	Technosphere	Sweden
Method: Total consumption of electricity (1997) / total amount of ground dolomite produced 1997 = 1560 MWh el. / 34 000 t ground dolomite = 0,4588 MWh/t	Input	Refined resource	Electricity	0.165			MJ	Technosphere	Sweden
Method: An average value for emissions of particulates (dust) to air were given in mg/h and the assumed yearly operating time was 3000 h/year. Total emissions per year were then calculated and divided by total amounts of dolomite ground in 1997. Emissions of particulates occur at two points. 4 mg/Nm3 * 5900 Nm3/h + 2 mg/Nm3 * 5900 Nm3/h = 35 400 mg/h Operation time: 3000 h/year (35 400 mg/h * 3000 h/year) / 34 000 t ground dolomite/year = 3,12 g particulates/t ground dolomite	Output	Emission	Particles	0.0031			g	Air	Sweden
	Output	Product	Dolomite	1			kg	Technosphere	Sweden

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --

Intended User	The data are intended to be us
General Purpose	To generate an inventory for emissions and use of resources due to the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare different fertilisers with each other but to generate a thorough inventory of emissions and use of resources due to the production of different mineral fertilisers used in Sweden. Grinding of dolomite is one process step in the line of production of calcium ammonium nitrate (CAN) produced in Landskrona. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The dataset is applicable for data on grinding of dolomite in Sweden. The dolomite is mixed with ammonium nitrate to produce calcium ammonium nitrate (CAN). The dataset is included in the aggregated datset for production of CAN at Hydro Agri AB in Landskrona (cradle to gate).
About Data	Data is collected from the official environmental report distributed by Hydro Agri AB in Landskrona and also with personal communication with people working there.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chamers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Handpolishing of bearing rollers

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Handpolishing of bearing rollers
Functional Unit	One bearing roller: 9,2 kg
Functional Unit Explanation	One spherical roller bearing 232/530 consists of following components: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 rollers (coated or non-coated) The functional unit for this process is one bearing roller. Note however that the data only represent the last handpolishing step in the manufacturing process. For the complete system see the activity ''Production of bearing rollers (á 9,2 kg)'' in SPINE@CPM database.
Process Type	Unit operation
Site	SKF Sverige AB415 50 GÖTEBORG
Sector	Materials and components
Owner	SKF Sverige AB415 50 GÖTEBORG
Technical system description	This activity is a process step included in the system: ''Production of bearing rollers (à 9,2 kg)'' (can be found in the SPINE@CPM database) This activity represents the last process step for the manufacturing of bearing rollers at SKFs site in Göteborg, Sweden. The rollers are being polished by hand in order to get a smooth surface.

	The dataset include energy consumption for hand polishing and the amount of grinding paper used. The grinding paper used is bought from Slipnaxos AB in Västervik, where the production of the grinding paper takes place. The production of grinding paper could be approximated with the activity ''Production of Kraftliner'' from SPINE@CPM database. Neither Production of Kraftliner nor the transport from Västervik to Göteborg are included in this dataset, but the Production of Kraftliner is included though in the complete data system: ''Production of bearing rollers (à 9,2 kg)'' When the rollers have been hand polished they are ready for assembling and are mounted into the SKF spherical roller bearing 232/530.

System Boundaries

Nature Boundary	Emissions to air are not measured and could therefore not be reported in this study. Emissions to water and the use of cutting fluid at SKF, Göteborg, could according to allocation difficulties and lack of time not be calculated.
Time Boundary	The data was collected during the autumn 2002.
Geographical Boundary	The process is site specific for SKF in Göteborg, Sweden.
Other Boundaries	The electricity production is NOT included in this dataset, but must be accounted for to get the complete environmental impact. The impact from the production and disposal of the cutting fluid is not included in this dataset, since no data was available. The grinding paper is not followed from the cradle but must be taken into account for the complete environmental impact. The production of grinding paper could be approximated with the activity ''Production of Kraftliner'' from SPINE@CPM database.
Allocations	Energy consumption depends on how long the rollers is processed in the different process equipment. This varies according to weight, but also according to size and desired properties of the final product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	Data is gathered from interviews with Niclas Thim, SKF Large Bearings, Sweden.
Literature Reference	Miljörapport (official environmental report) 1997, Hydro Agri AB, Box 516, 261 24 Landskrona, Sweden. Personal communication: Ronnie Persson, Hydro Agri AB in Landskrona, tel: +46 418 76100.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	bearing roller	9.2			kg	Technosphere	
	Input	Refined resource	Electricity	0.0013			kWh	Technosphere	Sweden
	Input	Refined resource	grinding paper	49			g	Technosphere	
	Output	Product	bearing roller	9.2			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ------------ Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.

Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valild for bearing rollers of the same material and weight and with the same processing equipment.
About Data	Data is gathered from interviews with Niclas Thim, SKF Large Bearings, Sweden.
Notes	

SPINE LCI dataset: Heating of ingot at the rolling mill

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Heating of ingot at the rolling mill
Functional Unit	One ton of heated ingot
Functional Unit Explanation	The heated ingot will be further processed into bearing rings, used in SKF spherical roller bearing 232/530.
Process Type	Unit operation
Site	Ovako Steel AB SE-813 82 Hofors
Sector	Materials and components
Owner	Ovako Steel AB SE-813 82 Hofors
Technical system description	This activity is a process step in the whole system ''Production of bearing rings'', this activity is available in the SPINE@CPM database. Heating of ingot at the rolling mill: At the rolling mill at Ovako Steel in Hofors the ingots are rolled into billets. The ingots are first heated in a soaking pit to the proper rolling temperature. When the ingot has been rolled in the first stand of rolls it is transported to the oxygen-scarfing machine where surface defects are removed from the billet. The billet rolling is then continued in rolling stand 2 and 3. Depending on what will become of the ingot it is rolled to round or square billets. Finally the billets are inspected and surface defects, if any, are removed by grinding. IN this specific case the ingot is only heated in the soaking pit at the rolling mill. Instead of rolling in the rolling stands the ingot is transported to Scana Steel AB in Söderfors for forging into bars. (the transport from Hofors to Söderfors is NOT included in this dataset)

System Boundaries	
Nature Boundary	Emission to air and water are included. Emissions to soil are not known. The water recipient is Hoån, Sweden.
Time Boundary	All data refers to year 1999. No changes are planned for the nearest future.
Geographical Boundary	The rolling mill is located at Ovako Steel AB in Hofors,Sweden.

Other Boundaries	Production of light and heavy fuel oil is NOT included but must be followed from the cradle. Production of LPG is not included but must be followed from the cradle. No transport is included.
Allocations	Allocation have been made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	The data is obtained from Ovako Steel AB and are specific values for their rolling mill. Much of the data refers according to the plant manager to year 1999
Literature Reference	Miljörapport (official environmental report) 1997, Hydro Agri AB, Box 516, 261 24 Landskrona, Sweden. Personal communication: Ronnie Persson, Hydro Agri AB in Landskrona, tel: +46 418 76100.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Brick	288			g	Technosphere	Europe
	Input	Refined resource	Dolomite	91.5			g	Technosphere	Europe
Date concieved: 2002 Data type: Calculated Method: The data was given in kg/functional unit. The heating value: 40 MJ/kg was used to recalculate the data into MJ. Literature: Hellsten, G and Mörstedt, S-E; Data och Diagram Energi- och kemitekniska tabeller; 23-27;Liber Utbildning; 1996	Input	Refined resource	Heavy fuel oil	876			MJ	Technosphere	Europe
	Input	Refined resource	Hydraulic Oil	0.6			g	Technosphere	Europe
	Input	Refined resource	Ingot Mould	1026			kg	Technosphere	Europe
Date concieved: 2002 Data type: Calculated Method: The data was given in kg/functional unit. The heating value: 41 MJ/kg was used to recalculate the data into MJ. Literature: Hellsten, G and Mörstedt, S-E; Data och Diagram Energi- och kemitekniska tabeller; 23-27;Liber Utbildning; 1996	Input	Refined resource	Light fuel oil	43.05			MJ	Technosphere	Europe
Date concieved: 2002 Data type: Calculated Method: The data was given in kg/functional unit. The heating value: 46 MJ/kg was used to recalculate the data into MJ. Literature: Hellsten, G and Mörstedt, S-E; Data och Diagram Energi- och kemitekniska tabeller; 23-27;Liber Utbildning; 1996	Input	Refined resource	Liquefied petroleum gas	105.2			MJ	Technosphere	Europe
	Input	Refined resource	Oxygen	21.3			kg	Technosphere	Europe
	Input	Refined resource	Water	59.4			kg	Water	Sweden
	Output	Emission	CO2	247.2			kg	Air	Sweden
	Output	Emission	NOx	495			g	Air	Sweden
	Output	Emission	SO2	300			g	Air	Sweden
	Output	Product	Ingots	1000			kg	Technosphere	Sweden
	Output	Residue	Pit Furnace Slag	38.85			kg	Technosphere	Sweden

About Inventory	
Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	LCA practitioners in general.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data can be applied generally for heating of ingot at the rolling mill at Ovako Steel AB in Hofors
About Data	Data is gathered from interviews with Eva-Maria Arvidsson at Ovako Steel AB in Hofors.
Notes	

SPINE LCI dataset: Heating of smelt iron in a holding furnace

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Heating of smelt iron in a holding furnace
Functional Unit	6,59 kg heated smelt iron
Functional Unit Explanation	6,59 kg smelt iron is used to produce one bearing housing, SNL 511-609, at SKF Mekan AB in Katrineholm. This activity is also included in the production of guide rings. The dataset is used unchanged for our specific case, and thus the functional unit is 6,59 kg smelt iron. The figure 6,59 has nothing to do with guide rings as such.
Process Type	Unit operation
Site	SKF Mekan ABBox 89 641 21 Katrineholm
Sector	Materials and components
Owner	SKF Mekan ABBox 89 641 21 Katrineholm
Technical system description	This activity describes a process step included in the system ''Production of guide rings used for spherical roller bearings'', also available in the SPINE@CPM database. The guide ring is manufactured at SKF Mekan AB in Katrineholm and the process consists of several steps. (See the activity ''Production of guide rings used for spherical roller bearings'' for details.) The guide ring will finally be mounted into the SKF Spherical Roller Bearing 232/530. The function of the guide ring is to assure that the rollers stay in the raceways of the bearing.

	After the smelting process, the smelt is transported in a ladle to the holding furnace to keep it heated. This activity describes the energy consumption for the heating of the smelt iron in the holding furnace. The production of electricity is NOT included in this dataset, bust must be followed from the cradle in order to obtain the total environmental impact. Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.

System Boundaries

Nature Boundary	No emissions to air and water are known. The dataset is only describing the electricity consumption for the furnace.
Time Boundary	The data was collected during the autumn 2002 and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The process takes place at SKF Mekan AB in Katrineholm, Sweden
Other Boundaries	The production of electricity is NOT included in this dataset, bust must be followed from the cradle in order to obtain the total environmental impact.
Allocations	Allocations were made according to weight
Systems Expansions	Not Applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity	3.87e6			J	Technosphere	
	Input	Refined resource	Iron	6.590			kg	Technosphere	
	Output	Product	Iron	6.590			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -

Applicability	The data set is applicable for the heating of smelt iron in the specific furnace (used before the casting process) at SKF Mekan ABs site in Katrineholm, Sweden.
About Data	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002. The environmental manager Marja Andersson at SKF Mekan AB in Katrineholm has provided information about the specific case with the production of guide rings.
Notes	

SPINE LCI dataset: Heavy truck with international semitrailer, max 40 tonnes, future

Administrative

Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System

Name	Heavy truck with international semitrailer, max 40 tonnes, future
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with international semitrailer with engine representing best available technology (proposed Euro 3 environmental standard) with oxidation filter and catalytic control. The towcar for the equipage is a truck, max 24 tonnes. The equipage is new and not frequently used in Swedish domestic traffic. Maximum gross weight: 40 tonnes. Kerb weight: 22 tonnes. Available loading capacity with regard to weight: 18 tonnes.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents best available technology, not yet in regular use.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle

	Excluded subsystems -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	The emissions were calculated using emission factors obtained by the a new test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level. See specific QMetaData for each flow.
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm	Input	Refined resource	Diesel environmental class 1	1.01			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.012			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	74			g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.012			g	Air	

Date concieved: 1996-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors (g/kWh) obtained by a a new test cycle, on the engine, where kWh refers to mechanical work done by the engine. The tests was perfomed by Motortestcenter. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/ (loading capacity [tonne]*utilisation level) **The following data was used in the calculations:** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,38 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data were supplied by the Swedish Petroleum Institute *The emission factors were:* NOx 6,3 g/kWh HC 0,4 g/kWh CO 0,7 g/kWh Particles 0,11 g/kWh Degree of efficiency on the engine: 41 % (assumption). The data can be found in Ahlvik. Literature: Ahlvik P., Almén J., Grägg K., Laveskog A. *Avgasemissioner med alternativa bränslen* Motortestcenter, februari 1996 (Published in SOU 1996:184 *Bilagor till betänkande av alternativbränsleutredningen*)	Output	Emission	NOx	0.58			g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.0023			g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00044			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport

	companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions. The data represents best available technology not yet in use.
About Data	The data is based on tests on the engine performed in a laboratory according to a new test cycle (proposed for standardisation). This means that several parameters that influence the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck with international semitrailer, max 40 tonnes, manufactured after 1996 [Euro 2]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck with international semitrailer, max 40 tonnes, manufactured after 1996 [Euro 2]
Functional Unit	1 tonkm, 70 %

Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with international semitrailer with engine manufactured after 1996 (Euro 2 environmental standard). The towcar for the equipage is a truck, max 24 tonnes. The equipage is new and not frequently used in Swedish domestic traffic. Maximum gross weight: 40 tonnes. Kerb weight: 22 tonnes. Available loading capacity with regard to weight: 18 tonnes.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured after 1996 (Euro 2)
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation, the *maximum value* refer to an engine run 500 000 km. No minimum value was given.
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	1.06	1.05	1.08	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.085		0.103	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	77	76	79	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.048		0.051	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refers to an engine run 500 000 km. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/ (loading capacity [tonne]*utilisation level) ***The following data was used in***	Output	Emission	NOx	0.76		0.78	g	Air	

the calculations: *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine*: -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data was supplied by Volvo Truck Corporation. *Maximum value i.e. engine run 500 000 km* The data was supplied by Volvo Truck Corporation and expressed as percentage degeneration in emissions in relation to the average engine. The degeneration factors are based on special degeneration factor tests for EPA/CARB on 12 litre engines. The tests were performed on four engines run 470 000 km. The degeneration factors are an average of the tests. -NOx 6,4 g/kWh - 1,5 % degeneration in relation to the average engine -HC 0,42 g/kWh - 4 % degeneration in relation to the average engine -CO 0,8 g/kWh - 20 % degeneration in relation to the average engine -Particles 0,11 g/kWh - 2 % degeneration in relation to the average engine -Degree of efficiency on the engine: 41 % (assumption) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx	Output	Emission	Particles	0.013		0.014	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refers to an engine run 500 000 km. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/ (loading	Output	Emission	SO2	0.00049	0.00046	0.0005	g	Air	

capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine*: -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data was supplied by Volvo Truck Corporation. *Maximum value i.e. engine run 500 000 km* The data was supplied by Volvo Truck Corporation and expressed as percentage degeneration in emissions in relation to the average engine. The degeneration factors are based on special degeneration factor tests for EPA/CARB on 12 litre engines. The tests were performed on four engines run 470 000 km. The degeneration factors are an average of the tests. -NOx 6,4 g/kWh - 1,5 % degeneration in relation to the average engine -HC 0,42 g/kWh - 4 % degeneration in relation to the average engine -CO 0,8 g/kWh - 20 % degeneration in relation to the average engine -Particles 0,11 g/kWh - 2 % degeneration in relation to the average engine -Degree of efficiency on the engine: 41 % (assumption) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature.									

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport

	companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 %

	The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck with international semitrailer, max 40 tonnes, manufactured before 1992 [Euro 0]

Administrative	
Finished	Y
Date Completed	1997-11-19

Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck with international semitrailer, max 40 tonnes, manufactured before 1992 [Euro 0]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with international semitrailer with engine manufactured before 1992 (Euro 0 environmental standard). The towcar for the equipage is a truck, max 24 tonnes.The equipage is new and not frequently used in Swedish domestic traffic. Maximum gross weight: 40 tonnes. Kerb weight: 22 tonnes. Available loading capacity with regard to weight: 18 tonnes.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured before 1992
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1997-11-01
Data Type	Derived, unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For

	emissions of NOx, HC, particles and CO, the quantity value refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to voluntary European emission regulations for diesel engines before 1992.
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	1.06	1.05	1.07	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.17		1.4	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	77	77	78	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.17		0.29	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors (g/kWh) obtained by a standardised test cycle, ECE R49 on the engine, where kWh refers to mechanical work done by the engine. The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in	Output	Emission	NOx	1.3	1	1.6	g	Air	

g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to voluntary European emission regulations for diesel engines before 1992. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/ (loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:*: -NOx 11 g/kWh -HC 1,5 g/kWh -CO 1,5 g/kWh -Particles 0,4 g/kWh (estimated) -Degree of efficiency on the engine:39 % (assumed) The data was supplied by the Volvo Truck Corporation. *Maximum value, i.e. voluntary European emission regulations:* -NOx 14 g/kWh -HC 2,5 g/kWh -CO 12 g/kWh -Particles - g/kWh (not given) -Degree of efficiency on the engine: 39 %. No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx	Output	Emission	Particles	0.046			g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information Notes: Since exhaust emissions	Output	Emission	SO2	0.00049	0.00048	0.0005	g	Air	

depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in

	Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for

	road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck with international semitrailer, max 40 tonnes, manufactured between 1992 and 1995[Euro1]

Administrative

Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System

Name	Heavy truck with international semitrailer, max 40 tonnes, manufactured between 1992 and 1995[Euro1]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with international semitrailer with engine manufactured between 1992 and 1995 (Euro 1 environmental standard). The towcar for the equipage is a truck, max 24 tonnes. The equipage is new and not frequently used in Swedish domestic traffic. Maximum gross weight of the equipage: 40 tonnes. Kerb weight: 22 tonnes. Available loading capacity with regard to weight: 18 tonnes.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured between 1992 and 1995
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc.

	-Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	Average electricity generation with fuel gas in the UCTPE countries in the early nineties.
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to the emission regulations for diesel engines according to the emission standard Euro I.
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	1.06	1.05	1.07	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.12		0.54	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The***	Output	Emission	CO2	77	77	78	g	Air	

following data was used in the calculations: *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information									
Method: See QMetaData for NOx	Output	Emission	HC	0.06		0.13	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to emission regulations for diesel engines according to the emission standard Euro I. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/ (loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:* -NOx 7,6 g/kWh -HC 0,5 g/kWh -CO 1,0 g/kWh -Particles 0,2 g/kWh -Degree of efficiency on the engine: 40 % (assumed) The data was supplied by the Volvo Truck Corporation *Maximum value, i.e. emission standard Euro I for diesel engines:* -NOx 8 g/kWh -HC 1,1 g/kWh -CO 4,5 g/kWh -Particles 0,36 g/kWh -Degree of efficiency on the engine: 40 % (assumed) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines.* Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.	Output	Emission	NOx	0.9		0.95	g	Air	

Method: See QMetaData for NOx	Output	Emission	Particles	0.022			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,38 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00049	0.00048	0.0005	g	Air	

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal

The collection and distribution routes are generally performed by smaller vehicles

--*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport.
--*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited
--*Parcel goods (<100 kg)* are normally handled in small vehicles

The following vehicles and equipages are used for transportation in Sweden:
--*Truck max 3,5 tonnes* is mainly used for transportation of parcels.
--*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic.
--*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic.
--*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic.

Utilisation level
The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

The Swedish fleet
The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories:
After 1996: 10 %
95-92: 33%
Before 1992 52 %
The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions.

International road transports
The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.

About Data

Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc.

Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years.

The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle

	that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck with one trailer, long distance, Euro 0

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Heavy truck with one trailer, long distance, Euro 0
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is considered to be representative for Swedish domestic long-distance traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of heavy truck with one trailer for long distance transports, approximately 18 m long with a curb weight of 40 tons and a maximum load of 26 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 3.8 l/10 km, medium 3.5 l/10 km, low 3.2 l/10 km. Engine type: Euro 0 (1987-1992). Utilisation level: 70% by weight.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1987 - 1992
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.19	0.17	0.20	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden

	Output	Emission	CO	0.071	0.065	0.077	g	Air	Sweden
	Output	Emission	CO2	50	46	54	g	Air	Sweden
	Output	Emission	HC	0.040	0.037	0.044	g	Air	Sweden
	Output	Emission	NOx	0.85	0.77	0.92	g	Air	Sweden
	Output	Emission	Particles	0.019	0.018	0.021	g	Air	Sweden
	Output	Emission	SO2	6.2E-05	5.7E-05	6.8E-05	g	Air	Sweden

About Inventory	
Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle.

Handling of goods
The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials)
Terminal based road transports generally consists of 1-3 parts:
1. Collection of the goods to terminal
2. Long-distance transport between terminals
3. Distribution of the goods from terminal
The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation.

--*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport.
--*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited
--*Parcel goods (<100 kg)* are normally handled in small vehicles

The following vehicles and equipages are used in terminal based transport systems in Sweden:
--*Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels.
--*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic.
--*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic.
--*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--*Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic.

Utilisation level
The data is only applicable for an utilisation level of 70 % which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure.

International road transports
The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.

About Data

The calculations of data on heavy trucks are based on the fuel consumption of the vehicle. The fuel consumption data have been obtained by simulations of heavy vehicles in traffic under Swedish conditions. These simulations were made by Volvo Trucks and Scania, especially for NTM. The data on emissions are based on measurements in accordance with applicable standards for certification.

Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Heavy truck with one trailer, long distance, Euro 1

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Heavy truck with one trailer, long distance, Euro 1
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is considered to be representative for Swedish domestic long-distance traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of heavy truck with one trailer for long distance transports, approximately 18 m long with a curb weight of 40 tons and a maximum load of 26 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 3.8 l/10 km, medium 3.5 l/10 km, low 3.2 l/10 km. Engine type: Euro 1 (1991-1995). Utilisation level: 70% by weight.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1991 - 1995
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behaviour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.19	0.17	0.20	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.065	0.060	0.071	g	Air	Sweden
	Output	Emission	CO2	50	46	54	g	Air	Sweden
	Output	Emission	HC	0.035	0.032	0.038	g	Air	Sweden
	Output	Emission	NOx	0.52	0.47	0.56	g	Air	Sweden
	Output	Emission	Particles	0.010	0.009	0.010	g	Air	Sweden
	Output	Emission	SO2	6.2E-05	5.7E-05	6.8E-05	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation

Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used in terminal based transport systems in Sweden:*** *--Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for an utilisation level of 70 % which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of

	haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The calculations of data on heavy trucks are based on the fuel consumption of the vehicle. The fuel consumption data have been obtained by simulations of heavy vehicles in traffic under Swedish conditions. These simulations were made by Volvo Trucks and Scania, especially for NTM. The data on emissions are based on measurements in accordance with applicable standards for certification.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Heavy truck with one trailer, long distance, Euro 2

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System

Name	Heavy truck with one trailer, long distance, Euro 2
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is considered to be representative for Swedish domestic long-distance traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of heavy truck with one trailer for long distance transports, approximately 18 m long with a curb weight of 40 tons and a maximum load of 26 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 3.8 l/10 km, medium 3.5 l/10 km, low 3.2 l/10 km. Engine type: Euro 2 (1993-1999). Utilisation level: 70% by weight.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1993 - 1999
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under*

	actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.19	0.17	0.20	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.048	0.044	0.052	g	Air	Sweden
	Output	Emission	CO2	50	46	54	g	Air	Sweden
	Output	Emission	HC	0.025	0.023	0.027	g	Air	Sweden
	Output	Emission	NOx	0.44	0.40	0.48	g	Air	Sweden
	Output	Emission	Particles	0.0067	0.0062	0.0073	g	Air	Sweden
	Output	Emission	SO2	6.2E-05	5.7E-05	6.8E-05	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .

Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used in terminal based transport systems in Sweden:*** *--Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for an utilisation level of 70 % which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally

	accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The calculations of data on heavy trucks are based on the fuel consumption of the vehicle. The fuel consumption data have been obtained by simulations of heavy vehicles in traffic under Swedish conditions. These simulations were made by Volvo Trucks and Scania, especially for NTM. The data on emissions are based on measurements in accordance with applicable standards for certification.
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Heavy truck with one trailer, long distance, made before 1990

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Heavy truck with one trailer, long distance, made before 1990
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is considered to be representative for Swedish domestic long-distance traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden

Technical system description	Operation of heavy truck with one trailer for long distance transports, approximately 18 m long with a curb weight of 40 tons and a maximum load of 26 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 3.8 l/10 km, medium 3.5 l/10 km, low 3.2 l/10 km. Engine type: made before 1990. Utilisation level: 70% by weight.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced before 1990
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behaviour etc.. The emissions of CO_2 and SO_2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	

Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.19	0.17	0.20	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.15	0.14	0.17	g	Air	Sweden
	Output	Emission	CO2	50	46	54	g	Air	Sweden
	Output	Emission	HC	0.12	0.11	0.13	g	Air	Sweden
	Output	Emission	NOx	1.0	0.9	1.1	g	Air	Sweden
	Output	Emission	Particles	0.058	0.053	0.063	g	Air	Sweden
	Output	Emission	SO2	6.2E-05	5.7E-05	6.8E-05	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on

the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used.

The age categories of the vehicles compiled in the work are:
Older than 1990,
Euro 0: Introduced 1987, law from 1990
Euro 1: Introduced 1991, law from 1993
Euro 2: Introduced 1993, law from 1996
However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle.

Handling of goods
The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials)
Terminal based road transports generally consists of 1-3 parts:
1. Collection of the goods to terminal
2. Long-distance transport between terminals
3. Distribution of the goods from terminal
The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation.

--Wholesale goods (>1000 kg) are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport.
--General goods (100-1000 kg) are generally handled via terminal. The goods may be both weight and volume limited
--Parcel goods (<100 kg) are normally handled in small vehicles

The following vehicles and equipages are used in terminal based transport systems in Sweden:
--Parcel truck/van, max 3,5 tonnes is mainly used for transportation of parcels.
--Light truck, max 8 tonnes is used for local distribution, mainly in city traffic.
--Truck, max 18 tonnes is used for district distribution and local distribution in city traffic.
--Truck, max 24 tonnes is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--Heavy truck with trailer, max 60 tonnes is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--Truck with semi-trailer, max 42 tonnes is used for international long-distance traffic.

Utilisation level
The data is only applicable for an utilisation level of 70 % which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure.

	International road transports The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The calculations of data on heavy trucks are based on the fuel consumption of the vehicle. The fuel consumption data have been obtained by simulations of heavy vehicles in traffic under Swedish conditions. These simulations were made by Volvo Trucks and Scania, especially for NTM. The data on emissions are based on measurements in accordance with applicable standards for certification.
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Heavy truck with trailer, max 60 tonnes, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck with trailer, max 60 tonnes, future
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with international semitrailer with engine representing best available technology (proposed Euro 3 environmental standard) with oxidation filter and catalytic control. The towcar for the equipage is a truck, max 24 tonnes. The equipage is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The equipage is also permitted in Finland. Maximum gross weight: 60 tonnes. Kerb weight: 20 tonnes. Available loading capacity with regard to weight: 40 tonnes. Length 24 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents best available technology, not yet in regular use.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by a new test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level. See specific QMetaData for each flow.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99	Input	Refined resource	Diesel environmental class 1	0.54			MJ	Technosphere	

in relation to the average engine -maximum value:1,01 in relation to the average engine									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.0061			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	39			g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.0061			g	Air	
Date concieved: 1996-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors (g/kWh) obtained by a a new test cycle, on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The tests was perfomed by Motortestcenter. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) **The following data was used in the calculations:** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data were supplied by the Swedish Petroleum Institute *The emission factors were:* -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data can be found in Ahlvik. Literature: Ahlvik P., Almén J., Grägg K., Laveskog A. *Avgasemissioner med alternativa bränslen* Motortestcenter, februari 1996 (Published in SOU 1996:184 *Bilagor till betänkande av alternativbränsleutredningen*)	Output	Emission	NOx	0.31			g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.0012			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00024			g	Air	

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions. The data represents best available technology, not yet in use.
About Data	The data is based on tests on the engine performed in a laboratory according to a new test cycle (proposed for standardisation). This means that several parameters that influence the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck with trailer, max 60 tonnes, manufactured after 1996 [Euro 2]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck with trailer, max 60 tonnes, manufactured after 1996 [Euro 2]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with trailer, with engine manufactured after 1996 (Euro 2 environmental standard). The towcar for the equipage is a truck, max 24 tonnes. The equipage is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The equipage is also permitted in Finland. Maximum gross weight: 60 tonnes. Kerb weight: 20 tonnes. Available loading capacity with regard to weight: 40 tonnes. Length 24 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured after 1996
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation, the *maximum value* refer to an engine run 500 000 km. No minimum value was given.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	0.57	0.56	0.57	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.045		0.055	g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	41	41	42	g	Air	

Method: See QMetaData for NOx	Output	Emission	HC	0.026		0.027	g	Air		
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refers to an engine run 500 000 km. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine*: -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data was supplied by Volvo Truck Corporation. *Maximum value i.e. engine run 500 000 km* The data was supplied by Volvo Truck Corporation and expressed as percentage degeneration in emissions in relation to the average engine. The degeneration factors are based on special degeneration factor tests for EPA/CARB on 12 litre engines. The tests were performed on four engines run 470 000 km. The degeneration factors are an average of the tests. -NOx 6,4 g/kWh - 1,5 % degeneration in relation to the average engine -HC 0,42 g/kWh - 4 % degeneration in relation to the average engine -CO 0,8 g/kWh - 20 % degeneration in relation to the average engine -Particles 0,11 g/kWh - 2 % degeneration in relation to the average engine -Degree of efficiency on the engine: 41 % (assumption) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.	Output	Emission	NOx	0.406		0.418	g	Air		

Method: See QMetaData for NOx	Output	Emission	Particles	0.0071		0.0073	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00026		0.00027	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal

The collection and distribution routes are generally performed by smaller vehicles

--*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport.
--*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited
--*Parcel goods (<100 kg)* are normally handled in small vehicles

The following vehicles and equipages are used for transportation in Sweden:
--*Truck max 3,5 tonnes* is mainly used for transportation of parcels.
--*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic.
--*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic.
--*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic.

Utilisation level
The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

The Swedish fleet
The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories:
After 1996: 10 %
95-92: 33%
Before 1992 52 %
The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions.

International road transports
The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.

About Data

Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc.

Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years.

The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle

	that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck with trailer, max 60 tonnes, manufactured before 1992 [Euro 0]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck with trailer, max 60 tonnes, manufactured before 1992 [Euro 0]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with trailer with engine manufactured before 1992 (Euro 0 environmental standard). The towcar for the equipage is a truck, max 24 tonnes. The equipage is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The equipage is also permitted in Finland. Maximum gross weight: 60 tonnes. Kerb weight: 20 tonnes. Available loading capacity with regard to weight: 40 tonnes. Length 24 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured before 1992
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to voluntary European emission regulations for diesel engines before 1992.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,45 l/km.	Input	Refined resource	Diesel environmental class 1	0.57	0.56	0.57	MJ	Technosphere	

-Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.09		0.74	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	41	41	42	g	Air	
Method: See QMetaData for NOx.	Output	Emission	HC	0.09		0.15	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to voluntary European emission regulations for diesel engines before 1992. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/ (loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:*: -NOx 11 g/kWh -HC 1,5 g/kWh -CO 1,5 g/kWh -Particles 0,4 g/kWh (estimated) -Degree of efficiency on the engine:39 % (assumed) The data was supplied by the Volvo Truck Corporation. *Maximum value, i.e.*	Output	Emission	NOx	0.67	0.55	0.87	g	Air	

voluntary European emission regulations: -NOx 14 g/kWh -HC 2,5 g/kWh -CO 12 g/kWh -Particles - g/kWh (not given) -Degree of efficiency on the engine: 39 %. No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx.	Output	Emission	Particles	0.024			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO_2	0.00026	0.00026	0.00027	g	Air	

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use

	today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions.

	Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck with trailer, max 60 tonnes, manufactured between 1992 and 1995 [Euro1]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck with trailer, max 60 tonnes, manufactured between 1992 and 1995 [Euro1]
Functional Unit	1 tonkm, 70 %

Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with trailer with engine manufactured between 1992 and 1995 (Euro 1 environmental standard). The towcar for the equipage is a truck, max 24 tonnes. The equipage is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The equipage is also permitted in Finland. Maximum gross weight: 60 tonnes. Kerb weight: 20 tonnes. Available loading capacity with regard to weight: 40 tonnes. Length 24 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: $SO2$ -tax regulated $CO2$. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured between 1992 and 1995
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of $CO2$ and $SO2$ is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to the emission regulations for diesel engines according to the emission standard Euro I.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year’s time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-03-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	0.57	0.56	0.57	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.06		0.29	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	41	41	42	g	Air	
Method: See QMetaData for NOx.	Output	Emission	HC	0.03		0.07	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to emission regulations for diesel engines according to the emission standard Euro I. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading	Output	Emission	NOx	0.48		0.51	g	Air	

capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:* -NOx 7,6 g/kWh -HC 0,5 g/kWh -CO 1,0 g/kWh -Particles 0,2 g/kWh -Degree of efficiency on the engine: 40 % (assumed) The data was supplied by the Volvo Truck Corporation *Maximum value, i.e. emission standard Euro I for diesel engines:* -NOx 8 g/kWh -HC 1,1 g/kWh -CO 4,5 g/kWh -Particles 0,36 g/kWh -Degree of efficiency on the engine: 40 % (assumed) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx.	Output	Emission	Particles	0.012			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,45 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00026	0.00025	0.00026	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods

General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips.* During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15%

	-mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck with two trailers, long distance, Euro 0

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Heavy truck with two trailers, long distance, Euro 0
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is considered to be representative for Swedish domestic long-distance traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of heavy truck with two trailers for long distance transports, approximately 24 m long with a curb weight of 60 tons and a maximum load of 40 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 5,5 l/10 km, medium 4,9 l/10 km, low 4,3 l/10 km. Engine type: Euro 0 (1987-1992). Utilisation level: 70% by weight.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1987 - 1992
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1998 - 08

Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.17	0.15	0.19	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.065	0.057	0.073	g	Air	Sweden
	Output	Emission	CO2	46	40	51	g	Air	Sweden
	Output	Emission	HC	0.037	0.032	0.041	g	Air	Sweden
	Output	Emission	NOx	0.77	0.68	0.86	g	Air	Sweden
	Output	Emission	Particles	0.018	0.015	0.020	g	Air	Sweden
	Output	Emission	SO2	5.7E-05	5.0E-05	6.4E-05	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation

Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used in terminal based transport systems in Sweden:*** *--Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for an utilisation level of 70 % which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally

	have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The calculations of data on heavy trucks are based on the fuel consumption of the vehicle. The fuel consumption data have been obtained by simulations of heavy vehicles in traffic under Swedish conditions. These simulations were made by Volvo Trucks and Scania, especially for NTM. The data on emissions are based on measurements in accordance with applicable standards for certification.
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Heavy truck with two trailers, long distance, Euro 1

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System

Name	Heavy truck with two trailers, long distance, Euro 1
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is considered to be representative for Swedish domestic long-distance traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of heavy truck with two trailers for long distance transports, approximately 24 m long with a curb weight of 60 tons and a maximum load of 40 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 5,5 l/10 km, medium 4,9 l/10 km, low 4,3 l/10 km. Engine type: Euro 1 (1992-1995). Utilisation level: 70% by weight.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1991 - 1995
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO_2 and SO_2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under*

	actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.17	0.15	0.19	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.060	0.052	0.067	g	Air	Sweden
	Output	Emission	CO2	46	40	51	g	Air	Sweden
	Output	Emission	HC	0.032	0.028	0.035	g	Air	Sweden
	Output	Emission	NOx	0.47	0.41	0.53	g	Air	Sweden
	Output	Emission	Particles	0.0088	0.0077	0.010	g	Air	Sweden
	Output	Emission	SO2	5.7E-05	5.0E-05	6.4E-05	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .

Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used in terminal based transport systems in Sweden:*** *--Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent

	weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The calculations of data on heavy trucks are based on the fuel consumption of the vehicle. The fuel consumption data have been obtained by simulations of heavy vehicles in traffic under Swedish conditions. These simulations were made by Volvo Trucks and Scania, especially for NTM. The data on emissions are based on measurements in accordance with applicable standards for certification.
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Heavy truck with two trailers, long distance, Euro 2

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Heavy truck with two trailers, long distance, Euro 2
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is considered to be representative for Swedish domestic long-distance traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden

Technical system description	Operation of heavy truck with two trailers for long distance transports, approximately 24 m long with a curb weight of 60 tons and a maximum load of 40 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 5,5 l/10 km, medium 4,9 l/10 km, low 4,3 l/10 km. Engine type: Euro 2 (1996-). Utilisation level: 70% by weight.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1993 - 1999
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	

Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.17	0.15	0.19	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.044	0.038	0.049	g	Air	Sweden
	Output	Emission	CO2	46	40	51	g	Air	Sweden
	Output	Emission	HC	0.023	0.020	0.026	g	Air	Sweden
	Output	Emission	NOx	0.40	0.35	0.45	g	Air	Sweden
	Output	Emission	Particles	0.0061	0.0054	0.0069	g	Air	Sweden
	Output	Emission	SO2	5.7E-5	5.0E-5	6.4E-5	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on

the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used.

The age categories of the vehicles compiled in the work are:
Older than 1990,
Euro 0: Introduced 1987, law from 1990
Euro 1: Introduced 1991, law from 1993
Euro 2: Introduced 1993, law from 1996
However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle.

Handling of goods
The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials)
Terminal based road transports generally consists of 1-3 parts:
1. Collection of the goods to terminal
2. Long-distance transport between terminals
3. Distribution of the goods from terminal
The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation.

--Wholesale goods (>1000 kg) are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport.
--General goods (100-1000 kg) are generally handled via terminal. The goods may be both weight and volume limited
--Parcel goods (<100 kg) are normally handled in small vehicles

The following vehicles and equipages are used in terminal based transport systems in Sweden:
--Parcel truck/van, max 3,5 tonnes is mainly used for transportation of parcels.
--Light truck, max 8 tonnes is used for local distribution, mainly in city traffic.
--Truck, max 18 tonnes is used for district distribution and local distribution in city traffic.
--Truck, max 24 tonnes is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--Heavy truck with trailer, max 60 tonnes is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--Truck with semi-trailer, max 42 tonnes is used for international long-distance traffic.

Utilisation level
The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based

	on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The calculations of data on heavy trucks are based on the fuel consumption of the vehicle. The fuel consumption data have been obtained by simulations of heavy vehicles in traffic under Swedish conditions. These simulations were made by Volvo Trucks and Scania, especially for NTM. The data on emissions are based on measurements in accordance with applicable standards for certification.
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Heavy truck with two trailers, long distance, made before 1990

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Heavy truck with two trailers, long distance, made before 1990
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is considered to be representative for Swedish domestic long-distance traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of heavy truck with two trailers for long distance transports, approximately 24 m long with a curb weight of 60 tons and a maximum load of 40 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 5,5 l/10 km, medium 4,9 l/10 km, low 4,3 l/10 km. Engine type: made before 1990. Utilisation level: 70% by weight.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2.

	Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced before 1990
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.17	0.15	0.19	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.14	0.12	0.16	g	Air	Sweden
	Output	Emission	CO2	46	40	51	g	Air	Sweden
	Output	Emission	HC	0.11	0.092	0.12	g	Air	Sweden
	Output	Emission	NOx	0.91	0.80	1.0	g	Air	Sweden

	Output	Emission	Particles	0.053	0.046	0.059	g	Air	Sweden
	Output	Emission	SO2	5.7E-05	5.0E-05	6.4E-05	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil

and excavated materials)
Terminal based road transports generally consists of 1-3 parts:
1. Collection of the goods to terminal
2. Long-distance transport between terminals
3. Distribution of the goods from terminal
The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation.

--*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport.
--*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited
--*Parcel goods (<100 kg)* are normally handled in small vehicles

The following vehicles and equipages are used in terminal based transport systems in Sweden:
--*Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels.
--*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic.
--*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic.
--*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--*Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic.

Utilisation level
The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ’’Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik’’, Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure.

International road transports
The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.

About Data

The calculations of data on heavy trucks are based on the fuel consumption of the vehicle. The fuel consumption data have been obtained by simulations of heavy vehicles in traffic under Swedish conditions. These simulations were made by Volvo Trucks and Scania, especially for NTM. The data on emissions are based on measurements in accordance with applicable standards for certification.

Notes

The person stated as ’’Practitioner’’ is the contact person for the data for truck transportation in NTM.
The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage:

	http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Heavy truck, max 18 tonnes, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck, max 18 tonnes, future
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven truck with engine representing best available technology (proposed Euro 3 environmental standard) with oxidation filter and catalytic control.The vehicle is mainly used for district distribution and local distribution in city traffic. Maximum gross weight: 18 tonnes. Kerb weight: 9,5 tonnes. Available loading capacity with regard to weight: 8 tonnes. Length 9 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents best available technology, not yet in regular use.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle

	Excluded subsystems -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by a new test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level. See specific QMetaData for each flow.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	2.1			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.024			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum*	Output	Emission	CO2	153			g	Air	

Institute: -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information									
Method: See QMetaData for NOx	Output	Emission	HC	0.024			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors (g/kWh) obtained by a a new test cycle, on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The tests was perfomed by Motortestcenter. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) **The following data was used in the calculations:** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,35 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data were supplied by the Swedish Petroleum Institute *The emission factors were:* -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data can be found in Ahlvik. Literature: Ahlvik P., Almén J., Grägg K., Laveskog A. *Avgasemissioner med alternativa bränslen* Motortestcenter, februari 1996 (Published in SOU 1996:184 *Bilagor till betänkande av alternativbränsleutredningen*)	Output	Emission	NOx	1.2			g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.0048			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00092			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods

General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions. The data represents best available technology, not yet in use.
About Data	The data is based on tests on the engine performed in a laboratory according to a new test cycle (proposed for standardisation). This means that several parameters that influence the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck, max 18 tonnes, manufactured after 1996 [Euro 2]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck, max 18 tonnes, manufactured after 1996 [Euro 2]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven truck with engine manufactured after 1996 (Euro 2 environmental standard). The vehicle is mainly used for district distribution and local distribution in city traffic. Maximum gross weight: 18 tonnes. Kerb weight: 9,5 tonnes. Available loading capacity with regard to weight: 8 tonnes. Length 9 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured after 1996
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation, the *maximum value* refer to an engine run 500 000 km. No minimum value was given.
Literature Reference	

Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	2.2	2.17	2.23	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.18		0.21	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,35 l/km.r> -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	161	158	163	g	Air	
Method: See QMetaData for NOx.	Output	Emission	HC	0.1		0.11	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refers to an engine run 500 000 km. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:*	Output	Emission	NOx	1.6		1.6	g	Air	

(Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,35 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine*: -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data was supplied by Volvo Truck Corporation. *Maximum value i.e. engine run 500 000 km* The data was supplied by Volvo Truck Corporation and expressed as percentage degeneration in emissions in relation to the average engine. The degeneration factors are based on special degeneration factor tests for EPA/CARB on 12 litre engines. The tests were performed on four engines run 470 000 km. The degeneration factors are an average of the tests. -NOx 6,4 g/kWh - 1,5 % degeneration in relation to the average engine -HC 0,42 g/kWh - 4 % degeneration in relation to the average engine -CO 0,8 g/kWh - 20 % degeneration in relation to the average engine -Particles 0,11 g/kWh - 2 % degeneration in relation to the average engine -Degree of efficiency on the engine: 41 % (assumption) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx.	Output	Emission	Particles	0.028		0.029	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refers to an engine run 500 000 km. No minimum value was given. *The*	Output	Emission	SO2	0.00101	0.00095	0.00104	g	Air	

following formula was used to calculate the emissions per tonkm: (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,35 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine*: -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data was supplied by Volvo Truck Corporation. *Maximum value i.e. engine run 500 000 km* The data was supplied by Volvo Truck Corporation and expressed as percentage degeneration in emissions in relation to the average engine. The degeneration factors are based on special degeneration factor tests for EPA/CARB on 12 litre engines. The tests were performed on four engines run 470 000 km. The degeneration factors are an average of the tests. -NOx 6,4 g/kWh - 1,5 % degeneration in relation to the average engine -HC 0,42 g/kWh - 4 % degeneration in relation to the average engine -CO 0,8 g/kWh - 20 % degeneration in relation to the average engine -Particles 0,11 g/kWh - 2 % degeneration in relation to the average engine -Degree of efficiency on the engine: 41 % (assumption) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 --- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM ---

Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport*. The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):

	-excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck, max 18 tonnes, manufactured before 1992 [Euro 0]

Administrative

Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System

Name	Heavy truck, max 18 tonnes, manufactured before 1992 [Euro 0]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven truck with engine manufactured before 1992 (Euro 0 environmental standard).The vehicle is mainly used for district distribution and local distribution in city traffic. Maximum gross weight: 18 tonnes. Kerb weight: 9,5 tonnes. Available loading capacity with regard to weight: 8 tonnes. Length 9 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured before 1992
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData	
Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to voluntary European emission regulations for diesel engines before 1992.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-03-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	2.2	2.18	2.22	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.4		2.9	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further	Output	Emission	CO2	161	159	162	g	Air	

information									
Method: See QMetaData for NOx.	Output	Emission	HC	0.36		0.6	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to voluntary European emission regulations for diesel engines before 1992. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/ (loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,35 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:*: -NOx 11 g/kWh -HC 1,5 g/kWh -CO 1,5 g/kWh -Particles 0,4 g/kWh (estimated) -Degree of efficiency on the engine:39 % (assumed) The data was supplied by the Volvo Truck Corporation. *Maximum value, i.e. voluntary European emission regulations:* -NOx 14 g/kWh -HC 2,5 g/kWh -CO 12 g/kWh -Particles - g/kWh (not given) -Degree of efficiency on the engine: 39 %. No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.	Output	Emission	NOx	2.6	2.1	3.4	g	Air	
Method: See QMetaData for NOx.	Output	Emission	Particles	0.095			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to	Output	Emission	SO2	0.00101	0.001	0.00104	g	Air	

weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information									

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and

wholesale (partigods) goods.
--*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport*. The vehicle is also permitted in Finland.
--*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic.

Utilisation level
The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

The Swedish fleet
The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories:
After 1996: 10 %
95-92: 33%
Before 1992 52 %
The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions.

International road transports
The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.

About Data

Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc.

Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years.

The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions.

A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute.

The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).

Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck, max 18 tonnes, manufactured between 1992 and 1995 [Euro1]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck, max 18 tonnes, manufactured between 1992 and 1995 [Euro1]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven truck with engine manufactured between 1992 and 1995 (Euro 1 environmental standard). The vehicle is mainly used for district distribution and local distribution in city traffic. Maximum gross weight: 18 tonnes. Kerb weight: 9,5 tonnes. Available loading capacity with regard to weight: 8 tonnes. Length 9 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured between 1992 and 1995

Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to the emission regulations for diesel engines according to the emission standard Euro I.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-03-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in	Input	Refined resource	Diesel environmental class 1	2.2	2.18	2.22	MJ	Technosphere	

relation to the average engine									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.2		1.1	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	161	159	162	g	Air	
Method: See QMetaData for NOx.	Output	Emission	HC	0.12		0.27	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to emission regulations for diesel engines according to the emission standard Euro I. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:* -NOx 7,6 g/kWh -HC 0,5 g/kWh -CO 1,0 g/kWh -Particles 0,2 g/kWh -Degree of efficiency on the engine: 40 % (assumed) The data was supplied by the Volvo Truck Corporation *Maximum value, i.e. emission standard Euro I for diesel engines:* -NOx 8 g/kWh -HC 1,1 g/kWh -CO 4,5 g/kWh -Particles 0,36 g/kWh -Degree of efficiency on the engine: 40 % (assumed) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall	Output	Emission	NOx	1.9		2	g	Air	

emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx.	Output	Emission	Particles	0.046			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,35 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00101	0.00099	0.00103	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 --- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM ---
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	

Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.

About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck, max 24 tonnes, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck, max 24 tonnes, future
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden

Technical system description	Operation of a diesel driven heavy truck with engine representing best available technology (proposed Euro 3 environmental standard) with oxidation filter and catalytic control. The vehicle is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. Maximum gross weight: 24 tonnes. Kerb weight: 10 tonnes. Available loading capacity with regard to weight: 14 tonnes. Length 24 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents best available technology, not yet in regular use.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by a new test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level. See specific QMetaData for each flow.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year’s time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:***	Input	Refined resource	Diesel environmental class 1	1.27			MJ	Technosphere	

Assumptions given by the Swedish Road Haulage Association: -Average fuel consumption: 0,37 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.014			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	93			g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.014			g	Air	
Date concieved: 1996-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors (g/kWh) obtained by a a new test cycle, on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The tests was perfomed by Motortestcenter. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) **The following data was used in the calculations:** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data were supplied by the Swedish Petroleum Institute *The emission factors were:* -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data can be found in Ahlvik. Literature: Ahlvik P., Almén J., Grägg K., Laveskog A. *Avgasemissioner med alternativa bränslen* Motortestcenter, februari 1996 (Published in SOU 1996:184 *Bilagor till betänkande av alternativbränsleutredningen*)	Output	Emission	NOx	0.72			g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.0029			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the***	Output	Emission	SO2	0.00056			g	Air	

***calculations:** Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information									

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions. The data represents best available technology, not yet in use.
About Data	The data is based on tests on the engine performed in a laboratory according to a new test cycle (proposed for standardisation). This means that several parameters that influence the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different

	transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck, max 24 tonnes, manufactured after 1996 [Euro 2]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck, max 24 tonnes, manufactured after 1996 [Euro 2]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with engine manufactured after 1996 (Euro 2 environmental standard). The vehicle is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. Maximum gross weight: 24 tonnes. Kerb weight: 10 tonnes. Available loading capacity with regard to weight: 14 tonnes. Length 24 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured after 1996
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure

	-After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation, the *maximum value* refer to an engine run 500 000 km. No minimum value was given.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,37 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	1.33	1.31	1.35	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.11		0.13	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km. -Utilisation	Output	Emission	CO2	97	96	98	g	Air	

level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information									
Method: See QMetaData for NOx.	Output	Emission	HC	0.061		0.064	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refers to an engine run 500 000 km. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine*: -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data was supplied by Volvo Truck Corporation. *Maximum value i.e. engine run 500 000 km* The data was supplied by Volvo Truck Corporation and expressed as percentage degeneration in emissions in relation to the average engine. The degeneration factors are based on special degeneration factor tests for EPA/CARB on 12 litre engines. The tests were performed on four engines run 470 000 km. The degeneration factors are an average of the tests. -NOx 6,4 g/kWh - 1,5 % degeneration in relation to the average engine -HC 0,42 g/kWh - 4 % degeneration in relation to the average engine -CO 0,8 g/kWh - 20 % degeneration in relation to the average engine -Particles 0,11 g/kWh - 2 % degeneration in relation to the average engine -Degree of efficiency on the engine: 41 % (assumption) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines.* Consists of a sequence of 13 constant engine	Output	Emission	NOx	0.95		0.98	g	Air	

speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx.	Output	Emission	Particles	0.0167		0.0172	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00061	0.00058	0.00063	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .

Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** *--Truck max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel

	environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck, max 24 tonnes, manufactured before 1992 [Euro 0]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck, max 24 tonnes, manufactured before 1992 [Euro 0]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport

Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with engine manufactured before 1992 (Euro 0 environmental standard). The vehicle is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. Maximum gross weight: 24 tonnes. Kerb weight: 10 tonnes. Available loading capacity with regard to weight: 14 tonnes. Length 24 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured before 1992
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to voluntary European emission regulations for diesel engines before 1992.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-03-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel	Input	Refined resource	Diesel environmental class 1	1.33	1.32	1.34	MJ	Technosphere	

consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,37 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.22		1.75	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	97	96	98	g	Air	
Method: See QMetaData for NOx.	Output	Emission	HC	0.22		0.36	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to voluntary European emission regulations for diesel engines before 1992. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/ (loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the*	Output	Emission	NOx	1.6	1.3	2	g	Air	

Swedish Petroleum Institute: -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:*: -NOx 11 g/kWh -HC 1,5 g/kWh -CO 1,5 g/kWh -Particles 0,4 g/kWh (estimated) -Degree of efficiency on the engine:39 % (assumed) The data was supplied by the Volvo Truck Corporation. *Maximum value, i.e. voluntary European emission regulations:* -NOx 14 g/kWh -HC 2,5 g/kWh -CO 12 g/kWh -Particles - g/kWh (not given) -Degree of efficiency on the engine: 39 %. No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx.	Output	Emission	Particles	0.058			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00061	0.0006	0.00063	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of

	organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes.

	Bulky goods The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Heavy truck, max 24 tonnes, manufactured between 1992 and 1995 [Euro1]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)

Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Heavy truck, max 24 tonnes, manufactured between 1992 and 1995 [Euro1]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven heavy truck with engine manufactured between 1992 and 1995 (Euro 1 environmental standard). The vehicle is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. Maximum gross weight: 24 tonnes. Kerb weight: 10 tonnes. Available loading capacity with regard to weight: 14 tonnes. Length 24 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured between 1992 and 1995
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine

	guaranteed by Volvo Truck Corporation and the *maximum value* refer to the emission regulations for diesel engines according to the emission standard Euro I.
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,37 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	1.33	1.31	1.34	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.15		0.67	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	97	96	98	g	Air	
Method: See QMetaData for NOx.	Output	Emission	HC	0.07		0.16	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the	Output	Emission	NOx	1.1		1.2	g	Air	

maximum value refer to emission regulations for diesel engines according to the emission standard Euro I. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:* -NOx 7,6 g/kWh -HC 0,5 g/kWh -CO 1,0 g/kWh -Particles 0,2 g/kWh -Degree of efficiency on the engine: 40 % (assumed) The data was supplied by the Volvo Truck Corporation *Maximum value, i.e. emission standard Euro I for diesel engines:* -NOx 8 g/kWh -HC 1,1 g/kWh -CO 4,5 g/kWh -Particles 0,36 g/kWh -Degree of efficiency on the engine: 40 % (assumed) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx.	Output	Emission	Particles	0.028			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,37 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00061	0.0006	0.00062	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no

	general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different

	transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: High purity copper production from primary raw materials

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	High purity copper production from primary raw materials
Functional Unit	1 kg pure copper
Functional Unit Explanation	
Process Type	Gate to gate
Site	None
Sector	Materials and components
Owner	None
Technical system description	2.13 tons of copper concentrate containing 12% water are transported to mainly one plant in Germany where it is melted and refined to copper. The concentrate is melted in a suspension process with H_2SO_4 recycling in a converter with low slag production. 0.57 tons of scrap copper is added. The raw metal is refined and cast to anodes. The final refining is made through electrolysis to pure copper metal. H_2SO_4, copper slag, copper anode sludge and $NiSO_4$ are byproducts.

System Boundaries	
Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data	
General Activity QMetaData	
Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German average
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.

Notes	The total energy use for primary production is 21.8 MJ/kg (6.3 MJ for copper production and 15.5 for energy production). A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. The production of H2SO4 requires 13% of the primary energy used for the primary production.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	By-product	Copper anode sludge	0.01			kg	Technosphere	
	Output	By-product	Copper slag	1.12			kg	Technosphere	
	Output	By-product	H2SO4	1.88			kg	Technosphere	
	Output	By-product	NiSO4	0.01			kg	Technosphere	
	Output	Emission	CO	1.08			g	Air	
	Output	Emission	CO2	1.39			kg	Air	
	Output	Emission	HC	0.71			g	Air	
	Output	Emission	NO2	3.93			g	Air	
	Output	Emission	Particles	0.425			g	Air	
	Output	Emission	SO2	4.75			g	Air	
	Output	Emission	SO3	0.2			g	Air	
	Output	Residue	Acid sludge	0.001			kg	Ground	
	Output	Residue	Arsenic precipitate	0.002			kg	Ground	
	Output	Residue	Ashes	0.03			kg	Ground	
	Output	Residue	Gypsum	0.01			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- None .
Practitioner	- None .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	If a cradle to gate process is to be calculated, data for ore mining and concentration (data set ''Copper ore mining and concentration'') has to be added. For the primary production of pure copper products 0.57 of the values for ore mining and concentration should be added which for energy is 20MJ/kg. This because the emissions and energy use are expressed per kg copper in concentrate and the copper content is assumed to be 30 weight%.

SPINE LCI dataset: High purity copper production from secondary raw materials

Administrative

Finished	Y

Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System

Name	High purity copper production from secondary raw materials
Functional Unit	1 kg of pure copper
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany
Technical system description	0.58 tons of different secondary raw materials (slags, ashes, sludges) and 1.4 tons of copper scrap (copper, brass, bronze) are transported, melted and refined. The scrap is added in different steps, some to the first melting and refining of the low grade raw materials and some directly to the refining through electrolysis. Copper slag, fly ash, copper anode sludge and NiSO4 are produced as byproducts.

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German average
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for secondary production of pure copper is 20.55 MJ/kg (9.21 for copper production and 11.34 for energy production). A German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/km for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	By-product	Copper anode sludge	0.01			kg	Technosphere	
	Output	By-product	Copper slag	0.53			kg	Technosphere	
	Output	By-product	Fly ash	0.12			kg	Technosphere	
	Output	By-product	NiSO4	0.02			kg	Technosphere	
	Output	Emission	CO	3.52			g	Air	
	Output	Emission	CO2	1.96			kg	Air	
	Output	Emission	HC	0.23			g	Air	
	Output	Emission	NO2	3.2			g	Air	
	Output	Emission	Particles	0.31			g	Air	

	Output	Emission	SO2	4.32			g	Air	
	Output	Residue	Ashes	0.02			kg	Ground	
	Output	Residue	Gypsum	0.01			kg	Ground	
	Output	Residue	Waste water	1			kg	Water	

About Inventory	
Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology -- -- Data documented by: Alena Ashkin, ABB Corporate Research Data submitted to SPINE@CPM: 2 February. Documentation not yet reviewed --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments
Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung M.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	

SPINE LCI dataset: High sea shipping

Administrative	
Finished	Y
Date Completed	1994-04-01
Copyright	
Availability	Public

Technical System	
Name	High sea shipping
Functional Unit	tonkm
Functional Unit Explanation	The energy use and exhaust emissions are calculated with reference to the transportation of 1 ton goods, 1 kilometre.
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden

Technical system description	Operation of a ship used for high sea shipping

System Boundaries	
Nature Boundary	Emissions to air from combustion of the fuel are included. Other environmental impacts from the operation of the ship are not included.
Time Boundary	The aim was that the figures would represent the fleet in 1992.
Geographical Boundary	Sweden and other countries with a similar fleet
Other Boundaries	Utilisation level of the ship is not known. *Not included in the system:* Production and distribution of the fuel Manufacture and maintenance of the ship
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1990-1994
Data Type	Derived, unspecified
Represents	German average
Method	Data compiled from*different literature sources*. The emissions were calculated from emission factors; the emission factor for each specific substance was multiplied with the energy use for the given transport. The emission factors were: SO2 1,28 g/MJ NOx 2,5 g/MJ CO 0,22 g/MJ CO2 72 g/MJ HC 0,06 g/MJ Particles 0,11 g/MJ For details on how the emission factors were obtained, see metadata for each specific substance. Metadata for CO and HC can be found under CO. Metadata for SO2 and particles can be found under SO2.
Literature Reference	Tillman, A-M. ''Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.'' In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995
Notes	-

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes:	Input	Cargo	Cargo	1.000000			tonne	Technosphere	
Date concieved: 1990 Data type: Unspecified Method: The data for energy use for high sea shipping recommended by Tillman were found in Lenner. The recommendation was based on the energy use for high sea shipping found in Habersatter (0,2 MJ/tonkm). The energy use reported by Lenner are intended to represent an average value for all shipping in Sweden. The value is therefore a combination of several types of ships with energy use between 0,09 MJ/tonkm and 0,349 MJ/tonkm. Lenner found the energy use for different types of ships, loads and average speeds in figure A3:2 in Cordi. Cordi has however not stated how the background material for figure A3:2 was retrieved. Literature: Habersatter, K. ''Oekobilanz von Packstoffen - Stand 1990''. Schriftenreihe Umwelt nr 132, Bundesamt fur Umwelt, Walt und Landschaft (BUWAL), Bern 1991.Lenner, M. ''Energiförbrukning och avgasemission för olika transporttyper'' VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 Cordi, I et al, ''Energieffektiviteten för person- och godstransporter i Sverige. En jämförande analys. Appendix.'' TFD-rapport 1979:2, Transportforskningsdelegationen, 1979 Notes: *Reviewers comment:* The energy use for different types of ships can vary	Input	Refined resource	Heavy oil	0.18			MJ	Technosphere	

depending on e. g. size, shape of the hull, hydrodynamic properties and engine strength. This can give a very broad distribution in the energy use depending on which individu									
Notes:	Output	Cargo	Cargo	1.000000			tonne	Technosphere	
Date concieved: 1992 Data type: Unspecified Method: Lenner has calculated *average emission factors* in g/tonkm, intended to represent an average value for all shipping in Sweden. They are therefore calculated for a combination of several types of ships. Emission factors in g/MJ were obtained by division of the emission factors in g/tonkm by the average energy use (0,051 g/MJ). Lenner has not stated how the values were retrieved. Literature: Lenner, M. `Energiförbrukning och avgasemission för olika transporttyper` VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 Notes:	Output	Emission	CO	0.04			g	Air	
Date concieved: 1992 Data type: Modeled data Method: The emission factor was calculated from the fuel use (0,18 g/MJ) using the carbon content in diesel. The data used in the calculation was: Heat value: 42,82 MJ/kg Density: 0,83 kg/dm3 CO2 emission: 2,61 kg CO2/dm3 fuel Literature: Lenner, M. `Energiförbrukning och avgasemission för olika transporttyper` VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 Notes:	Output	Emission	CO2	13			g	Air	
Notes:	Output	Emission	HC	0.011			g	Air	
Date concieved: 1992 Data type: Unspecified Method: Lenner has calculated an *average emission factor* in g/tonkm, intended to represent an average value for all shipping in Sweden. They are therefore calculated for a combination of several types of ships. Emission factors in g/MJ were obtained by division of the emission factors in g/tonkm by the average energy use (0,051 g/MJ). The data was based on figures found in a document written by the Swedish Environmental Agency (Planeringsunderlag..). The emission factors in this document are given for four-stroke engines, and based on an investigation of exhaust emissions from shipping in Sweden made by Alexandersson. Data on specific emissions given in Alexandersson were mainly based on data from laboratory measurements by engine manufacturers but also measurements onboard three ships and other projects that has conducted measurements onboard sailing ships. Literature: Alexandersson, A. ''Sjöfartens utsläpp av avgaser'' TFB-meddelande nr 164, Transportforskningsdelegationen, Stockholm 1990. Lenner, M. ''Energiförbrukning och avgasemission för olika transporttyper'' VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 Planeringsunderlag för samordnad investeringsplanering 1994-2003. Statens Naturvårdsverk 1992-04-15 Notes:	Output	Emission	NOx	0.45			g	Air	
Notes:	Output	Emission	Particles	0.02			g	Air	
Date concieved: 1991 Data type: Unspecified Method: Exhaust emission factors in g/tonkm can be read in figure 25 in Alexandersson. To obtain emission factors in g/MJ, Tillman has divided the emission factors in g/tonkm with an energy use of 0,47 MJ/tonkm Figure 25 in Alexandersson is based on total exhaust	Output	Emission	SO2	0.23			g	Air	

emissions and transportation by domestic shipping in Sweden 1987. It is not however clear how the background data for figure 25 were collected. Literature: Alexandersson, A. ''Sjöfartens utsläpp av avgaser'' TFB-meddelande nr 164, Transportforskningsdelegationen, Stockholm 1990. Notes:									

About Inventory	
Publication	Tillman, A-M. `Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995 -- Documentation and review of the report done by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	To fulfil a need for *standard values* to calculate energy use and exhaust emissions from goods transports.
Detailed Purpose	An update of standard values for energy use and exhaust emissions from an earlier investigation in: *Tillman, A-M., Baumann, H., Eriksson, E., Rydberg, T.* `Livscykelanalyser för förpackningsmaterial - beräkning av miljöbelastning` SOU 1991:77, Allmänna förlaget, Stockholm, 1991.
Commissioner	- .
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	*Reviewers comment:* The data should be used with great care. The energy use for different types of ships can vary depending on e. g. size, shape of the hull, hydrodynamic properties and engine strength. This can give a very broad distribution in the energy use depending on which individual ships the energy use were based.
About Data	The emissions were calculated from the energy use and emission factors. The emission factors that were used and the basis for them can be found in general metadata.
Notes	

SPINE LCI dataset: Hot rolling of steel sheet

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Hot rolling of steel sheet
Functional Unit	1 kg hot rolled steel sheet
Functional Unit Explanation	Before the steel can be coated, different pre treatments has to be done. The steel from the steel mill is first hot rolled and then pickled. After the pickling process, the steel is cold reduced and then finally coated.
Process Type	Gate to gate

Site	SSAB Tunnplåt
Sector	Materials and components
Owner	SSAB Tunnplåt
Technical system description	This activity describes a process step included in the system ''Production of plywood boxes'', also available in the SPINE@CPM database. Plywood boxes are used to pack the coated and non-coated roller bearings from SKF, Göteborg, during the transportation to customers. The plywood boxes are manufactured by Nefab Emballage AB in Alfta, Sweden. The plywood box consist of plywood, steel strips, steel nails and wooden splits. The steel for the steel strips and steel nails is hot rolled, pickled, cold reduced and finally coated at SSAB Tunnplåt`s line in Borlänge. This dataset describes the hot rolling of 1 kg steel sheet at SSAB Tunnplåt AB in Borlänge. All data for the hot rolling processes is obtained from an already made LCA at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. The data refers to an existing EPD from SSAB Tunnplåt AB: Environmental Product Declaration from SSAB; SE 380; June 1999

System Boundaries

Nature Boundary	Emissions to air and water are included. The steel scrap from the process is reused as raw material and is thus not considered as waste, but as a co-product ending in the technosphere.
Time Boundary	This environmental profile refers to the mean values of emissions to which hot rolling of steel sheet gives rise in Borlänge during the years 1998-1999.
Geographical Boundary	The hot rolling of steel sheet takes place at SSAB Tunnplåt´s line in Borlänge, Sweden.
Other Boundaries	The production of electricity is NOT included in the dataset, but must be followed from the cradle in order to obtain the total environmental impact. This must also be done with the production of LPG and the production of oil.
Allocations	Allocations have been made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	German average
Method	All data for the process is obtained from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. The data refers to an existing EPD from SSAB Tunnplåt AB: Environmental Product Declaration from SSAB; SE 380; June 1999.
Literature Reference	Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. Environmental Product Declaration from SSAB; SE 380; June 1999.
Notes	-

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Electricity	0.08			kWh	Technosphere	Sweden
	Input	Refined resource	LPG	0.175			kWh	Technosphere	Sweden
	Input	Refined resource	Oil	0.215			kWh	Technosphere	Sweden
	Input	Refined resource	Steel	1.02			kg	Technosphere	Sweden
	Output	Co-product	Steam	0.07			kWh	Technosphere	Sweden
	Output	Co-product	Steel scrap	19			g	Technosphere	Sweden
	Output	Emission	CO2	100			g	Air	Sweden
	Output	Emission	Dust	0.008			g	Air	Sweden
	Output	Emission	NOx	0.169			g	Air	Sweden
	Output	Emission	Oil	0.0007			mg	Water	Sweden
	Output	Emission	Particles	0.004			mg	Water	Sweden
	Output	Emission	SO2	0.132			g	Air	Sweden
	Output	Product	Hot rolled steel sheet	1			kg	Technosphere	Sweden

		Output	Residue	Solid	1.1			g	Technosphere	Sweden

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. Both types of bearings are packed in a plywood box. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The dataset is applicable to hot rolling of steel sheet at SSAB Tunnplåt AB in Borlänge.
About Data	All data for the process is obtained from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. The data refers to an existing EPD from SSAB Tunnplåt AB: Environmental Product Declaration from SSAB; SE 380; June 1999.
Notes	

SPINE LCI dataset: Hungary, electricity generation mix 1998

Administrative

Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System

Name	Hungary, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Hungary
Sector	Energyware
Owner	Hungary
Technical system description	The generation of electricity with different power generating systems in Hungary during the year 1998.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	German average
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	130			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	13949			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	155			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	5963			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	7434			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	9557			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	37188			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.

Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: HVO combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30

Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System

Name	HVO combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of HVO to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from hydrotreated vegetable oil (HVO) combustion in heavy duty truck or bus, Euro VI, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	German average
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on WHTC (World Harmonized Transient Cycle for truck and bus engines), legislation limits for Euro VI (Commission Regulation (EC) No 582/2011).The WHTC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.44 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.
Literature Reference	Main references: (1) Commission Regulation (EC) No 582/2011 (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) Dir 2009/30/EC (5) HVO Handbook: Mikkonen, S. et al. (2012). HVO, Hydrotreated Vegetable Oil - A Premium Renewable Biofuel for Diesel Engines. Neste Oil Corporation, p. 15.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Product	Hydrotreated vegetable oil (HVO)	1			MJ	Technosphere	
Method: The fossil carbon content is per definition zero. Literature:	Output	Emission	Carbon dioxide (fossil)	0			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Carbon monoxide	4.88888888888889E-04			kg	Air	
Method: 10% of THC according to JRC (2013). Literature: JRC (2013)	Output	Emission	Methane	1.95555555555556E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Nitrogen oxides	5.62222222222222E-05			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	6.11111111111111E-06			kg	Air	
Method: THC minus CH4. Literature: THC is from limit in Euro VI legislation	Output	Emission	Non-methane volatile organic compounds	0.0000176			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Particles (unspecified)	1.22222222222222E-06			kg	Air	
Method: The legislative limit is 10 mg/kg (10 ppm) (Dir 2009/30/EC), but here a typical value is chosen. 1 kg of S generates 2 kg of SO2. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 44.1 MJ/kg (HVO Handbook). Literature: Typical value	Output	Emission	Sulfur dioxide	1.36054421768707E-07			kg	Air	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL

Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: HVO combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	HVO combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of HVO to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from hydrotreated vegetable oil (HVO) combustion in heavy duty truck or bus, Euro V, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	German average
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on ETC (transient test cycle for truck and bus engines), legislation limits for Euro V (2005/55/EC). The ETC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.44 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.
Literature Reference	Main references: (1) 2005/55/EC (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) Dir 2009/30/EC (5) HVO Handbook: Mikkonen, S. et al. (2012). HVO, Hydrotreated Vegetable Oil - A Premium Renewable Biofuel for Diesel Engines. Neste Oil Corporation, p. 15.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Literature: 0	Input	Product	Hydrotreated vegetable oil (HVO)	1			MJ	Technosphere	
Method: The fossil carbon content is per definition zero. Literature:	Output	Emission	Carbon dioxide (fossil)	0			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Carbon monoxide	4.88888888888889E-04			kg	Air	
Method: 10% of THC according to JRC (2013). Literature: JRC (2013)	Output	Emission	Methane	6.72222222222222E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Nitrogen oxides	2.44444444444444E-04			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	6.11111111111111E-06			kg	Air	
Method: THC minus CH4. Literature: THC is from limit in Euro V legislation	Output	Emission	Non-methane volatile organic compounds	0.0000605			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Particles (unspecified)	3.66666666666667E-06			kg	Air	
Method: The legislative limit is 10 mg/kg (10 ppm) (Dir 2009/30/EC), but here a typical value is chosen. 1 kg of S generates 2 kg of SO2. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel	Output	Emission	Sulfur dioxide	1.36054421768707E-07			kg	Air	

was 44.1 MJ/kg (HVO Handbook). Literature: Typical value									

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Hydro electricity energy system, EPD-version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für energie, Bern
Availability	Public

Technical System	
Name	Hydro electricity energy system, EPD-version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures are based on data from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996 and adapted to the demands of the EPD-guidelines (Environmental Product Declaration guidelines in Sweden). The main emphasis in ETH:s study has been in the description of hydro power plants typical for Switzerland and the alpine region, with power outputs between about 0.1 MW and 350 MW. Three types of power plants are distinguished, namely, run of river (without storage), water storage and pumped storage power plants. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e.

	data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle. Energyware (fuels and electricity) is used during construction (ground works), in material manufacturing processes, transports etc. Figures reported here are based on LCI results for two types of plants: hydro power plants with and without storage and represent the average hydro power in the UCPTE* countries 1990-1994. Average hydro power production in the UCPTE was 158 TWh/year in 1990-94 (plants with storage:48%, plants without storage 52%). The average operation time was about 2900 hours per year. Detailed data concerning the construction and demolition of hydro power plants including storages, has been gathered by ETH, i.e. figures reported here comprise only construction and demolition of hydro power plants. The following has been inventoried: - manufacture of materials from natural resources and scrap - manufacture of capital goods (rough estimation) - exploration and extraction of energyware - transports - ground works (excavation etc) - waste handling (different kinds of landfills, waste incineration plants) Energyware consumed in pumps used for seasonal storage has been accounted for. Following parameters and activities have been taken into account by ETH: consumption of cement, steel and explosives, transports, consumption of energyware during the construction phase (electricity and diesel), use of land, usable content in water storages, amount of turbine water. Figures concerning the three latter parameters are not reported here but are described under ''other boundaries''. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries

Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). ETH:s LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH. Vattenfall's criterion in selecting and aggregating ETH's LCI-results for electricity generation in the UCPTE region has been to make the figures usable as general electricity LCI data in EPDs according to Miljöstyrningsrådets guidelines. Especially parameters (emissions) which have established impact indices - accepted by the EPD system - for one or several environmental impact categories, have been picked out and aggregated as far possible. But also metal and energyware resources have been included, as well as waste, in spite of all waste handling processes related to this dataset being included with respect to use of resources and emissions. The latter is an adaption to other LCI data for electricity generation where waste amounts are reported (since those flows have not been followed to the grave). Since ETH claimes that most of the figures regarding metal emissions have an undefined amount of datagaps all metal emissions are aggregated except for a few which are specified separatly since they are reported for most processes in the lifecycle. Metals are reported as elements although they often are part of compounds. Measuring methods often just give the amounts of the different elements found. All hydrocarbons to water are aggregated to one parameter as well as halogenated organics, since no indices exist (that are accepted by the EPD system so far) for characterisation of the individual substances.
Time Boundary	The figures describe the average operation of studied plants in 1994. Figures concerning fuel extraction and processing represent an average of the early nineties. Descriptions and figures of different technical processes come from literature, contractors, public and private institutions and describe the situation of the late eighties. Electricity used during the lifecycle has been assumed to be a mix based on the average generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years). All processes, also those conducted in the past, have been assumed to use average technology of the early nineties.

	Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Alpine hydro power plants Low pressure hydro power with and without storage plants (rivers and channels) Cement 200 years 80 years Steel, reinforcement 100 years 80 years Steel, other 60 years 60 years Explosives 250 years 100 years Transports 150 years 60 years Energyware, construction 150 years 80 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	No geographical boundaries have been drawn except concerning the location of the studied plants in Switzerland and the consumption of generated electricity in the UCPTE* region. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. The ETH study comprises figures concerning use of land, usable content in water storages and amount of turbine water which have not been reported here. The two latter have been excluded due to lack of corresponding data in comparable studies. Use of land has been excluded here because of ETH's advanced approach. Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the indutrial revolution I Modified human impact larger than other species', low degree of culivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of intererst. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. they express use of land in the unit m2year which is different from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH specifies about 160 radioactive isotopes emitted to air and water. Radioactive emissions reported here are picked out in accordance with SETAC working group report on data quality and data availability (to be published in 2001). Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	The water flow in rivers is regulated not just to assure a electricity generation adapted to the electricity need but also to protect land from overflooding. All environmental load in connection with water regulation (dams etc) has however been layed on hydro power. The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average hydro power in the UCTPE countries (except pumped storage used for daily regulation of power production)
Method	The data has been adapted from the Ökoinventare von Energiesystemen, ETH Zürich 1996, and is an aggregation of the LCI results for the module ''electricity from hydro power, UCPTE'' (Strom ab Wasserkraft, UCPTE).
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Bauxite	2.51			kg	Ground	
	Input	Natural resource	Chromium in ore	0.786			kg	Ground	
	Input	Natural resource	Copper in ore	0.0578			kg	Ground	
Notes: From drillhole	Input	Natural resource	Crude oil	74.8			kg	Ground	
Notes: Before processing	Input	Natural resource	Hard coal	294			kg	Ground	
	Input	Natural resource	Iron in ore	179			kg	Ground	
	Input	Natural resource	Lead in ore	0.019			kg	Ground	
Notes: Before extraction	Input	Natural resource	Lignite	65.4			kg	Ground	
	Input	Natural resource	Limestone	655			kg	Ground	
	Input	Natural resource	Manganese in ore	0.771			kg	Ground	
Notes: Summation of ''Erdoelgas'' (40,9 MJ/Nm3), ''Grubengas'' (35,9 MJ/kg) and ''Rohgas'' (35 MJ/Nm3). Expressed as Natural gas with lower heating value (35 MJ/Nm3). The heating values are acquired from table III 8.1 in the methodology chapter in the Ökoinventare von Energiesystemen, ETH, Zürich 1996	Input	Natural resource	Natural gas	23.58			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.137			kg	Ground	
	Input	Natural resource	Palladium in ore	1.24E-08			kg	Ground	
	Input	Natural resource	Platinum in ore	1.44E-08			kg	Ground	
	Input	Natural resource	Rhodium in ore	1.32E-08			kg	Ground	
	Input	Natural resource	Rock salt	0.413			kg	Ground	
	Input	Natural resource	Uranium in ore	0.00449			kg	Ground	
	Input	Natural resource	Water	1.17E+04			kg	Ground	
	Input	Natural resource	Wood	2.95			kg	Ground	
	Input	Natural resource	Zinc in ore	0.000541			kg	Ground	

	Notes: Summation of Ag, Sn, Rh, Mo, Co.	Input	Refined resource	Metals	3.66E-04			kg	Technosphere	
		Output	Emission	1,2-Dichloroethane	5.31E-06			kg	Air	
		Output	Emission	Ag-110m	0.0126			kBq	Water	
		Output	Emission	Ag-110m	1.85E-06			kBq	Air	
		Output	Emission	Am-241	0.00456			kBq	Water	
		Output	Emission	Am-241	3.46E-05			kBq	Air	
	Notes: BOD5	Output	Emission	BOD	1.96E-02			kg	Water	
		Output	Emission	C-14	0.231			kBq	Water	
		Output	Emission	C-14	2.79			kBq	Air	
		Output	Emission	C-60	7.84E-05			kBq	Air	
		Output	Emission	Cd	1.12E-07			kg	Ground	
		Output	Emission	Cd	5.24E-05			kg	Water	
		Output	Emission	Cd	6.71E-05			kg	Air	
		Output	Emission	CFC-11	1.42E-06			kg	Air	
		Output	Emission	CFC-114	3.76E-05			kg	Air	
		Output	Emission	CFC-12	3.06E-07			kg	Air	
		Output	Emission	CFC-13	1.92E-07			kg	Air	
		Output	Emission	Cm alpha	0.00604			kBq	Water	
		Output	Emission	Cm alpha	5.49E-05			kBq	Air	
		Output	Emission	Cm-244	1.65E-09			kBq	Air	
	Notes: CN- is Cyanide ion	Output	Emission	CN-	5.18E-05			kg	Air	
		Output	Emission	CN-	7.62E-04			kg	Water	
		Output	Emission	CO	5.7908			kg	Air	
		Output	Emission	CO2	1044.7			kg	Air	
		Output	Emission	Co-58	0.0208			kBq	Water	
		Output	Emission	Co-58	5.25E-05			kBq	Air	
		Output	Emission	Co-60	1.0101			kBq	Water	
		Output	Emission	COD	0.0263			kg	Water	
		Output	Emission	Cr	2.25E-04			kg	Air	
		Output	Emission	Cr	2.31E-05			kg	Ground	
		Output	Emission	Cr	5.20E-03			kg	Water	
		Output	Emission	Cs-134	0.23364			kBq	Water	
		Output	Emission	Cs-134	1.31E-03			kBq	Air	
		Output	Emission	Cs-137	0.00254			kBq	Air	
		Output	Emission	Cs-137	2.14614			kBq	Water	
		Output	Emission	Dichloromethane	7.07E-07			kg	Air	
	Notes: 2,3,7,8-Tetrachlorodibenzo-p-Dioxin-equivalents	Output	Emission	Dioxin (TCDD)	604			ng	Air	
		Output	Emission	Dissolved solids	0.1952			kg	Water	
		Output	Emission	H-1301	2.90E-05			kg	Air	
		Output	Emission	H2S	0.009522			kg	Air	
		Output	Emission	H-3	28.6			kBq	Air	
		Output	Emission	H-3	6.83E+03			kBq	Water	
	Notes: Summation of AOX, 1,1,1-trichloroethane, chlorobenzene, dichloromonofluoromethane, ethylene dichloride, hexachlororethane, metylenchloride, tetrachloroethylene, trichloroethylene, trichloromethane.	Output	Emission	Halogenated organics	7.09E-05			kg	Water	
	Notes: Summation of Cl-, F- and I-.	Output	Emission	Halogenids	5.08E+00			kg	Water	
	Notes: Summation of I and Br.	Output	Emission	Halogens	4.00E-04			kg	Air	
		Output	Emission	HCFC-21	4.55E-05			kg	Air	
		Output	Emission	HCFC-22	3.37E-07			kg	Air	
		Output	Emission	HCl	0.05023			kg	Air	
	Notes: No available index. Same index as NMVOC.	Output	Emission	Hexachlorobenzene	2.52E-10			kg	Air	
		Output	Emission	Hexafluoroethane	2.73E-05			kg	Air	
		Output	Emission	HF	0.00691			kg	Air	
		Output	Emission	HFC-134a	3.88E-17			kg	Air	
		Output	Emission	Hg	2.02E-08			kg	Ground	
		Output	Emission	Hg	4.01E-05			kg	Air	
		Output	Emission	Hg	8.76E-06			kg	Water	

Notes: Summation of acenaphtene, acenaphtylene, alkane, alkene, aromats, benzene, butyl benzyl phtalat, bibutyl p-phtalat, dimethyl p-phtalat, ethylbenzen, volatile hydrocarbons, formaldehyd, glutaraldehyd, hydrocarbons, MTBE (Metyl Tertiary Butyl Eter), phenol, styrol, toluol, triethylenglycol, xylol.	Output	Emission	Hydrocarbons	7.17E-03			kg	Water	
	Output	Emission	I-129	0.00988			kBq	Air	
	Output	Emission	I-129	0.659			kBq	Water	
	Output	Emission	I-131	0.000447			kBq	Water	
	Output	Emission	I-131	0.00114			kBq	Air	
	Output	Emission	I-133	0.000117			kBq	Water	
	Output	Emission	I-133	0.000612			kBq	Air	
	Output	Emission	K-40	0.00616			kBq	Air	
	Output	Emission	K-40	0.0169			kBq	Water	
	Output	Emission	Kr-85	1.70E+05			kBq	Air	
Notes: Summation of the ions of following metals: Ag, Al, Ar, Ba, Be, Cs, Ca, Fe, K, Co, Mg, Mn, Mo, Na, Ni, Ru, Sb, Se, Sn, Sr, Ti, W.	Output	Emission	Metal ions	3.64E+00			kg	Water	
Notes: Summation of Al, As, Ca, Co, Cu, Fe, Mn, Ni, Sn.	Output	Emission	Metals	3.25E-02			kg	Ground	
Notes: Summation of Al, As, Ba, Be, Ca, Co, Cu, Fe, K, La, Mg, Mn, Mo, Ni, Pt, Sb, Sc, Se, Sn, Sr, Th, Ti, Tl, U, Zr.	Output	Emission	Metals	7.54E-02			kg	Air	
	Output	Emission	Methane	2.38706			kg	Air	
	Output	Emission	Mn-54	0.154972			kBq	Water	
	Output	Emission	Mn-54	1.88E-06			kBq	Air	
	Output	Emission	N	1.06E-05			kg	Ground	
	Output	Emission	N total	0.019072			kg	Water	
	Output	Emission	N2O	0.01536			kg	Air	
	Output	Emission	NH3	0.005601			kg	Air	
Notes: Summation of acetaldehyd, acetylene, aceton, acrolein, aldehyd, alkane, alkene, aromats, benzaldehyd, benzene, butan, buten, acetic acid, etan, etanol, etene, ethylbenzene, ethylenoxide (C2H4O), formaldehyd, heptan, hexan, metanol, MTBE (Metyl Tertiary Butyl Eter), NMVOC, pentane, phenol, propan, propen, propion aldehyd, propionic acid, styrol, toluol, xylol.	Output	Emission	NMVOC	9.47E-01			kg	Air	
	Output	Emission	NO2-	1.80E-04			kg	Water	
	Output	Emission	NO3-	0.007707			kg	Water	
Notes: as NO2	Output	Emission	NOx	3.196			kg	Air	
	Output	Emission	Np-237	0.000291			kBq	Water	
	Output	Emission	Oil	3.33E-03			kg	Ground	
	Output	Emission	Oil	7.45E-02			kg	Water	
	Output	Emission	P	0.000272			kg	Ground	
	Output	Emission	P total	7.62E-05			kg	Air	
	Output	Emission	PAH	6.30E-05			kg	Water	
Notes: Same index as NMVOC.	Output	Emission	PAH	9.92E-05			kg	Air	
	Output	Emission	Particles	2.0892			kg	Air	
	Output	Emission	Pb	1.27E-03			kg	Air	
	Output	Emission	Pb	2.31E-06			kg	Ground	
	Output	Emission	Pb	5.72E-03			kg	Water	
	Output	Emission	Pb-210	0.0134			kBq	Water	
	Output	Emission	Pb-210	0.0339			kBq	Air	
Notes: C6HCl5, no available index. Same index as NMVOC.	Output	Emission	Pentachlorobenzene	6.73E-10			kg	Air	
Notes: C6HCl5O, no available index. Same index as NMVOC.	Output	Emission	Pentachlorophenol	1.09E-10			kg	Air	
	Output	Emission	Po-210	0.0134			kBq	Water	
	Output	Emission	Po-210	0.0518			kBq	Air	

	Output	Emission	PO43-	2.90E-02			kg	Water	
	Output	Emission	Pu alpha	0.00011			kBq	Air	
	Output	Emission	Pu alpha	0.0181			kBq	Water	
	Output	Emission	Pu-238	4.10E-09			kBq	Air	
	Output	Emission	Ra-226	0.04009			kBq	Air	
	Output	Emission	Ra-226	84.23			kBq	Water	
Notes: Long-term emissions of Rn-222	Output	Emission	Rn-222	2.44E+05			kBq	Air	
	Output	Emission	Rn-222	2.66E+03			kBq	Air	
	Output	Emission	Ru-106	0.011			kBq	Air	
	Output	Emission	Ru-106	1.1			kBq	Water	
	Output	Emission	S	0.00278			kg	Ground	
Notes: Includes Tot-S, S-, S in H2S, S in sulphate, S in sulphite	Output	Emission	S total	8.84E-01			kg	Water	
	Output	Emission	Sb-124	0.00329			kBq	Water	
	Output	Emission	Sb-124	5.09E-07			kBq	Air	
	Output	Emission	Sb-125	0.000209			kBq	Water	
	Output	Emission	Sb-125	6.86E-08			kBq	Air	
	Output	Emission	SO2	2.865			kg	Air	
	Output	Emission	Sr-90	0.00181			kBq	Air	
	Output	Emission	Sr-90	2.20E-01			kBq	Water	
	Output	Emission	Suspended solids	0.2909			kg	Water	
	Output	Emission	Tc-99	0.115			kBq	Water	
	Output	Emission	Tc-99	7.69E-08			kBq	Air	
	Output	Emission	Tetrachloromethane	1.37E-06			kg	Air	
	Output	Emission	Tetrafluoromethane	0.000245			kg	Air	
	Output	Emission	Th-230	0.0122			kBq	Air	
	Output	Emission	Th-230	3.18			kBq	Water	
	Output	Emission	Th-232	0.00163			kBq	Air	
	Output	Emission	Th-232	0.00314			kBq	Water	
Notes: Summation of dissolved organic carbon, fat acids as C, volatile organic compounds as C, TOC.	Output	Emission	Total organic carbon	1.45E-01			kg	Water	
	Output	Emission	Tributyl tin	2.08E-05			kg	Water	
	Output	Emission	Trichloromethane	1.40E-07			kg	Air	
	Output	Emission	U-234	0.0132			kBq	Air	
	Output	Emission	U-234	0.0272			kBq	Water	
	Output	Emission	U-235	0.000638			kBq	Air	
	Output	Emission	U-235	0.0405			kBq	Water	
	Output	Emission	U-238	0.01766			kBq	Air	
	Output	Emission	U-238	0.069			kBq	Water	
	Output	Emission	V	1.42E-03			kg	Air	
	Output	Emission	V	2.39E-03			kg	Water	
	Output	Emission	Vinyl chloride	8.64E-07			kg	Air	
	Output	Emission	Xe-133	122			kBq	Air	
	Output	Emission	Zn	5.05E-03			kg	Air	
	Output	Emission	Zn	6.50E-03			kg	Water	
	Output	Emission	Zn	7.44E-05			kg	Ground	
	Output	Product	Electricity	1			TJ	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) and processing of hazardous waste is included.	Output	Residue	Hazardous waste	6.85E-01			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Highly radioactive waste	7.69E-07			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, no emissions from landfill assumed. Inert waste deposit is waste at landfill that are inert.	Output	Residue	Inert waste deposit	5.66E+03			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Low radioactive waste	1.98E-05			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Medium and low radioactive waste	9.41E-06			m3	Technosphere	

Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from landfill. Reactive waste deposit is waste at landfill that is still reactive.	Output	Residue	Reactive waste deposit	1.23E+01			kg	Technosphere	
Notes: Internal flow! Infrastructure of spreading vehicles and emissions are included. Land farming is a treatment of organic sludge, the sludge is spread on a piece of land and left to degrade. Sometimes plants are grown on the land, but those plants are destroyed.	Output	Residue	Waste in land farming	4.87E-01			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from incineration plant.	Output	Residue	Waste to incineration	2.42E-01			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www. energieforschung.ch -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their lifecycles. The results can be used in lifecycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans. Vattenfalls purpose - as a commissioner of putting ETH:s data into Spine format with metadata - is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines. Data is supposed to be used together with IEA statistics about electricity generation mixes in the OECD countries/regions.
Detailed Purpose	ETH:s aim was to examine some important aspects of the environmental impact of hydro power plants in the UCPTE. The consumption of cement, steel, explosives and energyware during the construction phase is considered as well as transports, usable content of storages and the amount of water passing the turbines. Plants with and without storages are studied.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	The LCI-results of the three types of plants studie in the ETH study are valid for hydro power in Switzerland but are supposed to be a rather good approximation for hydro power in UCPTE. The two types, hydro power plants with and without storage, have been summarized to one set of data ''Hydro Power in UCPTE'' in accordance with existing percentages of those types of plants in the UCPTE region. Only this aggregated set of data is reported here. The result of the third type of hydro power plant is reported under the name ''Hydro Power with pumped storage in UCPTE'' in ETH's study (this kind of power plant is used to convert base load to peak load electricity with an efficiency of about 70%). This set of data is aggregated and documented in accordance with the Swedish EPD-guidelines to be used in combination with IEA statistics concerning electricity generation mixes in OECD countries and regions together with other datasets - based on the ETH study - describing other power generation systems. The EPD-adapted power generation systems in Spine format are named as follows: Fuel gas electricity energy system, EPD-version Biofuel electricity energy system (approximation), EPD-version Hydro electricity energy system, EPD-version Lignite electricity energy system, EPD-version Nuclear electricity energy system, EPD-version Stone coal electricity energy system, EPD-version Wind electricity energy system, EPD-version

	IEA statistics for generation mixes 1998 exist in Spine format for the following 30 countries/regions: OECD total OECD North America OECD Pacific OECD Europe European Union Australia Austria Belgium Canada Czech Rpublic Denmark Finland France Germany Greece Hungary Iceland Ireland Italy Japan Korea Luxembourg Mexico Netherlands New Zealand Norway Poland Portugal Spain Sweden Switzerland Turkey United Kingdom United States
About Data	Only the most important construction materials have been inventoried as well as transports and energyware consumption during the construction phase, i.e. consumption of copper, concrete additives or possible recycling processes of scrapped material etc. have been excluded. Data quality regarding inventoried material and energyware amounts is high, since the sources are reliable. The division of the steel consumption in the three different steel qualities has however been estimated. Due to difficulties in finding detailed data regarding the construction of studied plants (some data has been estimated) the results should be seen as approximate. Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided). Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Publication, Notes and General metadata.
Notes	Reviewer of this specification of ETH:s data and metadata has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of aggregation of figures and of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. The technical committee of the Swedish Environmental Management Council - approval of method and aggregation of parameters Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut -- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 6 June 2001: <<< Changes made by Ann-Christin Pålsson, CPM based on discussions with Caroline Setterwall,

	Vattenfall AB. Comments: The following changes has been made in the nomenclature for in- and outflows: Mangane in ore -> changed to: Manganese in ore CH4 -> changed to: Methane (to be in accordance with the nomenclature specified in CPM report 2000:2) CN -> changed to: CN- Stone coal -> changed to: Hard coal (to be in accordance with the nomenclature specified in CPM report 2000:2) Other metals -> changed to: Metals Explanations of nomenclature (inserted in Notes for the specific flows): - CN- is Cyanide ion - Reactive waste deposit is waste at landfill that is still reactive. - Inert waste deposit is waste at landfill that are inert. Additional clarifications: - Note that the flows of waste in the table of in- and outflows are internal flows, i.e. they do NOT cross the system boundaries. All waste handling processes is included in the study with respect to use of resources and emissions. - Radioactive waste is accounted for in cubic metres. The product specific requirements for electricity and district heating generation (PSR 1998:1) in the Swedish EPD system states that waste shall be accounted for in gram. However, no conversion factors were given in the study. There are also no general conversion factors that are commonly used.

SPINE LCI dataset: Hydro electricity energy system, ETH - full version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für energie, Bern
Availability	Public

Technical System	
Name	Hydro electricity energy system, ETH - full version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures come from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996. The main emphasis in ETH:s study has been in the description of hydro power plants typical for Switzerland and the alpine region, with power outputs between about 0.1 MW and 350 MW. Three types of power plants are distinguished, namely, run of river (without storage), water storage and pumped storage power plants. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle. Energyware (fuels and electricity) is used during construction (ground works), in material manufacturing processes, transports etc. Figures reported here are based on LCI results for two types of plants: hydro power plants with and without storage and represent the average hydro power in the UCPTE* countries 1990-1994. Average hydro power production in the UCPTE was 158 TWh/year in 1990-94

	(plants with storage:48%, plants without storage 52%). The average operation time was about 2900 hours per year. Detailed data concerning the construction and demolition of hydro power plants including storages, has been gathered by ETH, i.e. figures reported here comprise only construction and demolition of hydro power plants. The following has been inventoried: - manufacture of materials from natural resources and scrap - manufacture of capital goods (rough estimation) - exploration and extraction of energyware - transports - ground works (excavation etc) - waste handling (different kinds of landfills, waste incineration plants) Energyware consumed in pumps used for seasonal storage has been accounted for. Following parameters and activities have been taken into account by ETH: consumption of cement, steel and explosives, transports, consumption of energyware during the construction phase (electricity and diesel), use of land, usable content in water storages, amount of turbine water. Figures concerning the three latter parameters are not reported here but are described under ''other boundaries''. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries

Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the industrial revolution I Modified human impact larger than other species', low degree of cultivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of interest. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is different from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH.
Time Boundary	The figures describe the average operation of studied plants in 1994. Figures concerning fuel extraction and processing represent an average of the early nineties. Descriptions and figures of different technical processes come from literature, contractors, public and private institutions and describe the situation of the late eighties. Electricity used during the lifecycle has been assumed to be a mix based on the average generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years). All processes, also those conducted in the past, have been assumed to use average technology of the early nineties. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows:

	Alpine hydro power plants Low pressure hydro power with and without storage plants (rivers and channels) Cement 200 years 80 years Steel, reinforcement 100 years 80 years Steel, other 60 years 60 years Explosives 250 years 100 years Transports 150 years 60 years Energyware, construction 150 years 80 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	No geographical boundaries have been drawn except concerning the location of the studied plants in Switzerland and the consumption of generated electricity in the UCPTE* region. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	The water flow in rivers is regulated not just to assure a electricity generation adapted to the electricity need but also to protect land from overflooding. All environmental load in connection with water regulation (dams etc) has however been layed on hydro power. The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average hydro power in the UCTPE countries (except pumped storage used for daily regulation of power production)
Method	The figures have been copied from the module ''Electricity from hydro power, UCPTE'' (Strom ab Wasserkraft, UCPTE) in the Ökoinventare von Energiesystemen, ETH Zürich 1996.
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	Multiple flows are reported for several emissions to air. This is because that in the original study emissions to air have been reported in three categories, indicated by one of the letters below following the substance name. - m = mobile (emissions from vehicles) - p = process (process specific emissions as for instance methane emissions during coal mining) - s = stationary (emissions from stationary combustion plants) This categorisation has however not been documented in this specification in the SPINE format.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Area II-III	1300			m2a	Ground	

	Input	Natural resource	Area III-IV	4.18			m2a	Ground	
	Input	Natural resource	Area II-IV	27.2			m2a	Ground	
	Input	Natural resource	Area IV-IV	0.0312			m2a	Ground	
	Input	Natural resource	Area, sea bed II-III	5.52			m2a	Ground	
	Input	Natural resource	Area, sea bed II-IV	0.569			m2a	Ground	
	Input	Natural resource	Barite	0.35			kg	Ground	
	Input	Natural resource	Bauxite	2.51			kg	Ground	
	Input	Natural resource	Bentonite	1.78			kg	Ground	
	Input	Natural resource	Chromium in ore	0.786			kg	Ground	
	Input	Natural resource	Clay	153			kg	Ground	
	Input	Natural resource	Copper in ore	0.0578			kg	Ground	
	Input	Natural resource	Crude oil	0.0748			tonne	Ground	
	Input	Natural resource	Gravel	4950			kg	Ground	
	Input	Natural resource	Hydro energy	1.28			TJ	Water	
	Input	Natural resource	Iron in ore	179			kg	Ground	
	Input	Natural resource	Lead in ore	0.019			kg	Ground	
	Input	Natural resource	Lignite	65.4			kg	Ground	
	Input	Natural resource	Limestone	655			kg	Ground	
	Input	Natural resource	Manganese in ore	0.771			kg	Ground	
	Input	Natural resource	Mine gas (methane)	2.24			kg	Ground	
	Input	Natural resource	Natural gas	15.3			Nm3	Ground	
	Input	Natural resource	Natural gas	5.12			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.137			kg	Ground	
	Input	Natural resource	Palladium in ore	1.24E-08			kg	Ground	
	Input	Natural resource	Platinum in ore	1.44E-08			kg	Ground	
	Input	Natural resource	Rhodium in ore	1.32E-08			kg	Ground	
	Input	Natural resource	Rock salt	0.413			kg	Ground	
	Input	Natural resource	Sand	0.58			kg	Ground	
	Input	Natural resource	Stone coal	294			kg	Ground	
	Input	Natural resource	Turbine water amount	6570000			m3	Water	
	Input	Natural resource	Uranium in ore	0.00449			kg	Ground	
	Input	Natural resource	Water	11700			kg	Ground	
	Input	Natural resource	Wood	0.00295			tonne	Ground	
	Input	Natural resource	Working amount in water storages	25000			m3a	Water	
	Input	Natural resource	Zinc in ore	0.000541			kg	Ground	
	Input	Refined resource	Cobalt	0.000000135			kg	Technosphere	
	Input	Refined resource	Molybdenum	7.33E-08			kg	Technosphere	

		Input	Refined resource	Rhenium	1.21E-08			kg	Technosphere	
		Input	Refined resource	Silver	0.000235			kg	Technosphere	
		Input	Refined resource	Tin	0.000131			kg	Technosphere	
		Output	Emission	1,1,1-Trichloroethane	1.78E-08			kg	Fresh water	
		Output	Emission	1,2-Dichloroethane	0.00000273			kg	Fresh water	
		Output	Emission	1,2-Dichloroethane	0.00000531			kg	Air	
		Output	Emission	Acenaphthylene	0.0000215			kg	Fresh water	
		Output	Emission	Acetaldehyde	0.000109			kg	Air	
		Output	Emission	Acetic acid	0.000491			kg	Air	
		Output	Emission	Acetone	0.000109			kg	Air	
		Output	Emission	Acetylene	0.000108			kg	Air	
		Output	Emission	Acids	0.000578			kg	Fresh water	
		Output	Emission	Acroleine	4.33E-08			kg	Air	
		Output	Emission	Ag	0.00000198			kg	Sea water	
		Output	Emission	Ag	0.000012			kg	Fresh water	
		Output	Emission	Ag-110m	0.00000185			kBq	Air	
		Output	Emission	Ag-110m	0.0126			kBq	Fresh water	
		Output	Emission	Al	0.00000533			kg	Sea water	
		Output	Emission	Al	0.0000305			kg	Air	
		Output	Emission	Al	0.00104			kg	Air	
		Output	Emission	Al	0.00403			kg	Air	
		Output	Emission	Al	0.00462			kg	Ground	
		Output	Emission	Al	0.474			kg	Fresh water	
		Output	Emission	Aldehydes	0.00000359			kg	Air	
		Output	Emission	Alkanes	0.0000568			kg	Fresh water	
		Output	Emission	Alkanes	0.000429			kg	Sea water	
		Output	Emission	Alkanes	0.000931			kg	Air	
		Output	Emission	Alkanes	0.00151			kg	Air	
		Output	Emission	Alkenes	0.00000336			kg	Air	
		Output	Emission	Alkenes	0.00000524			kg	Fresh water	
		Output	Emission	Alkenes	0.0000396			kg	Sea water	
		Output	Emission	Alkenes	0.000416			kg	Air	
		Output	Emission	Alpha radiator	0.0000015			kBq	Fresh water	
		Output	Emission	Am-241	0.0000346			kBq	Air	
		Output	Emission	Am-241	0.00456			kBq	Sea water	
		Output	Emission	AOX	0.00000512			kg	Sea water	
		Output	Emission	AOX	0.00000899			kg	Fresh water	
		Output	Emission	Ar-41	4.02			kBq	Air	
		Output	Emission	Aromates	0.000000336			kg	Air	
		Output	Emission	Aromates	0.0000619			kg	Air	
		Output	Emission	Aromatics	0.000269			kg	Fresh water	
		Output	Emission	Aromatics	0.00202			kg	Sea water	
		Output	Emission	As	0.00000108			kg	Sea water	
		Output	Emission	As	0.00000185			kg	Ground	
		Output	Emission	As	0.00000305			kg	Air	
		Output	Emission	As	0.0000248			kg	Air	
		Output	Emission	As	0.0000268			kg	Air	
		Output	Emission	As	0.000958			kg	Fresh water	
		Output	Emission	B	0.00000258			kg	Air	
		Output	Emission	B	0.0000498			kg	Sea water	
		Output	Emission	B	0.000213			kg	Fresh water	
		Output	Emission	B	0.00257			kg	Air	
		Output	Emission	Ba	0.00000945			kg	Air	
		Output	Emission	Ba	0.0000627			kg	Air	
		Output	Emission	Ba	0.00826			kg	Sea water	
		Output	Emission	Ba	0.0388			kg	Fresh water	
		Output	Emission	Ba-140	0.00000739			kBq	Air	
		Output	Emission	Ba-140	0.0000256			kBq	Fresh water	
		Output	Emission	Barite	0.0687			kg	Sea water	
		Output	Emission	Be	0.000000106			kg	Air	
		Output	Emission	Be	0.000000164			kg	Fresh water	
		Output	Emission	Be	0.000000718			kg	Air	
		Output	Emission	Benzaldehyde	2.26E-08			kg	Air	

	Output	Emission	Benzene	0.0000138			kg	Air	
	Output	Emission	Benzene	0.0000632			kg	Fresh water	
	Output	Emission	Benzene	0.000429			kg	Sea water	
	Output	Emission	Benzene	0.000603			kg	Air	
	Output	Emission	Benzene	0.000784			kg	Air	
	Output	Emission	Benzo(a)pyrene	0.0000168			kg	Air	
	Output	Emission	Benzo(a)pyrene	2.63E-08			kg	Air	
	Output	Emission	BOD	0.0000917			kg	Sea water	
	Output	Emission	BOD	0.0195			kg	Fresh water	
	Output	Emission	Br	0.00000354			kg	Air	
	Output	Emission	Br	0.000274			kg	Air	
	Output	Emission	Butane	0.00053			kg	Air	
	Output	Emission	Butane	0.00597			kg	Air	
	Output	Emission	Butene	0.000297			kg	Air	
	Output	Emission	C	0.0143			kg	Ground	
	Output	Emission	C-14	0.231			kBq	Sea water	
	Output	Emission	C-14	2.79			kBq	Air	
	Output	Emission	Ca	0.0000264			kg	Air	
	Output	Emission	Ca	0.00394			kg	Air	
	Output	Emission	Ca	0.00673			kg	Air	
	Output	Emission	Ca	0.0185			kg	Ground	
	Output	Emission	Ca	0.106			kg	Sea water	
	Output	Emission	Ca	0.383			kg	Fresh water	
	Output	Emission	Cd	0.000000112			kg	Ground	
	Output	Emission	Cd	0.000000183			kg	Air	
	Output	Emission	Cd	0.00000206			kg	Sea water	
	Output	Emission	Cd	0.000012			kg	Air	
	Output	Emission	Cd	0.0000503			kg	Fresh water	
	Output	Emission	Cd	0.0000549			kg	Air	
	Output	Emission	Cd-109	0.000000148			kBq	Fresh water	
	Output	Emission	Ce-141	0.000000172			kBq	Air	
	Output	Emission	Ce-141	0.00000383			kBq	Fresh water	
	Output	Emission	Ce-144	0.00000109			kBq	Fresh water	
	Output	Emission	Ce-144	0.000368			kBq	Air	
	Output	Emission	Ce-144	0.104			kBq	Sea water	
	Output	Emission	CFC-11	0.00000142			kg	Air	
	Output	Emission	CFC-114	0.0000376			kg	Air	
	Output	Emission	CFC-12	0.000000306			kg	Air	
	Output	Emission	CFC-13	0.000000192			kg	Air	
	Output	Emission	CH4	0.00236			kg	Air	
	Output	Emission	CH4	0.0147			kg	Air	
	Output	Emission	CH4	2.37			kg	Air	
	Output	Emission	Chlorinated solvents	0.0000198			kg	Fresh water	
	Output	Emission	Chlorobenzenes	4.62E-11			kg	Fresh water	
	Output	Emission	Cl-	1.69			kg	Sea water	
	Output	Emission	Cl-	3.36			kg	Fresh water	
	Output	Emission	ClO-	0.000142			kg	Sea water	
	Output	Emission	ClO-	0.000588			kg	Fresh water	
	Output	Emission	Cm alpha	0.0000549			kBq	Air	
	Output	Emission	Cm alpha	0.00604			kBq	Sea water	
	Output	Emission	Cm-242	1.82E-10			kBq	Air	
	Output	Emission	Cm-244	1.65E-09			kBq	Air	
	Output	Emission	CN	0.0000518			kg	Air	
	Output	Emission	CN	5.33E-13			kg	Air	
	Output	Emission	CN-	0.00000533			kg	Sea water	
	Output	Emission	CN-	0.000757			kg	Fresh water	
	Output	Emission	Co	0.000000101			kg	Ground	
	Output	Emission	Co	0.00000192			kg	Air	
	Output	Emission	Co	0.000015			kg	Air	
	Output	Emission	Co	0.0000427			kg	Air	
	Output	Emission	Co	0.000942			kg	Fresh water	
	Output	Emission	CO	0.0708			kg	Air	
	Output	Emission	CO	2.3			kg	Air	
	Output	Emission	CO	3.42			kg	Air	
	Output	Emission	CO2	29.7			kg	Air	

	Output	Emission	CO2	350			kg	Air	
	Output	Emission	CO2	665			kg	Air	
	Output	Emission	Co-57	0.0000263			kBq	Fresh water	
	Output	Emission	Co-57	3.17E-09			kBq	Air	
	Output	Emission	Co-58	0.0000525			kBq	Air	
	Output	Emission	Co-58	0.0208			kBq	Fresh water	
	Output	Emission	Co-60	0.0000784			kBq	Air	
	Output	Emission	Co-60	0.0221			kBq	Fresh water	
	Output	Emission	Co-60	0.988			kBq	Sea water	
	Output	Emission	COD	0.0027			kg	Sea water	
	Output	Emission	COD	0.0236			kg	Fresh water	
	Output	Emission	Cr	0.00000152			kg	Air	
	Output	Emission	Cr	0.0000231			kg	Ground	
	Output	Emission	Cr	0.0000398			kg	Air	
	Output	Emission	Cr	0.000184			kg	Air	
	Output	Emission	Cr(VI)	0.000000202			kg	Fresh water	
	Output	Emission	Cr3+	0.0000289			kg	Sea water	
	Output	Emission	Cr3+	0.00517			kg	Fresh water	
	Output	Emission	Cr-51	0.00000652			kBq	Air	
	Output	Emission	Cr-51	0.000564			kBq	Fresh water	
	Output	Emission	Cs	0.000000434			kg	Fresh water	
	Output	Emission	Cs	0.0000033			kg	Sea water	
	Output	Emission	Cs-134	0.00131			kBq	Air	
	Output	Emission	Cs-134	0.00264			kBq	Fresh water	
	Output	Emission	Cs-134	0.231			kBq	Sea water	
	Output	Emission	Cs-136	0.000000138			kBq	Fresh water	
	Output	Emission	Cs-137	0.00254			kBq	Air	
	Output	Emission	Cs-137	0.00614			kBq	Fresh water	
	Output	Emission	Cs-137	2.14			kBq	Sea water	
	Output	Emission	Cu	0.000000505			kg	Ground	
	Output	Emission	Cu	0.00000452			kg	Sea water	
	Output	Emission	Cu	0.000102			kg	Air	
	Output	Emission	Cu	0.000341			kg	Air	
	Output	Emission	Cu	0.000378			kg	Air	
	Output	Emission	Cu	0.00245			kg	Fresh water	
	Output	Emission	Di-(2-ethylhexyl) phthalate	3.77E-10			kg	Fresh water	
	Output	Emission	Dibutyl p-phthalate	2.18E-09			kg	Fresh water	
	Output	Emission	Dichloromethane	0.000000707			kg	Air	
	Output	Emission	Dichloromethane	0.0000321			kg	Fresh water	
	Output	Emission	Different beta	0.000000255			kBq	Air	
	Output	Emission	Dimethyl p-phthalate	1.37E-08			kg	Fresh water	
	Output	Emission	Dioxin (TCDD)	604			ng	Air	
	Output	Emission	Dissolved organic carbon	0.0000475			kg	Sea water	
	Output	Emission	Dissolved organic carbon	0.000178			kg	Fresh water	
	Output	Emission	Dissolved solids	0.0152			kg	Sea water	
	Output	Emission	Dissolved solids	0.18			kg	Fresh water	
	Output	Emission	Ethane	0.000879			kg	Air	
	Output	Emission	Ethane	0.00413			kg	Air	
	Output	Emission	Ethanol	0.000000925			kg	Air	
	Output	Emission	Ethanol	0.000217			kg	Air	
	Output	Emission	Ethene	0.00242			kg	Air	
	Output	Emission	Ethene	0.00542			kg	Air	
	Output	Emission	Ethylbenzene	0.0000101			kg	Fresh water	
	Output	Emission	Ethylbenzene	0.0000792			kg	Sea water	
	Output	Emission	Ethylbenzene	0.000138			kg	Air	
	Output	Emission	Ethylbenzene	0.000283			kg	Air	
	Output	Emission	F-	0.000033			kg	Sea water	
	Output	Emission	F-	0.0308			kg	Fresh water	
	Output	Emission	Fe	0.0000587			kg	Air	
	Output	Emission	Fe	0.000383			kg	Sea water	
	Output	Emission	Fe	0.00254			kg	Air	
	Output	Emission	Fe	0.00924			kg	Ground	
	Output	Emission	Fe	0.011			kg	Air	
	Output	Emission	Fe	0.254			kg	Fresh water	
	Output	Emission	Fe-59	0.000000454			kBq	Fresh water	

	Output	Emission	Fe-59	7.19E-08			kBq	Air	
	Output	Emission	Fission and rad. prod.	0.0136			kBq	Fresh water	
	Output	Emission	Formaldehyde	0.000000427			kg	Air	
	Output	Emission	Formaldehyde	0.00105			kg	Air	
	Output	Emission	Formaldehyde	6.18E-08			kg	Fresh water	
	Output	Emission	Glutaraldehyde	0.00000849			kg	Sea water	
	Output	Emission	H-1301	0.000029			kg	Air	
	Output	Emission	H2S	0.000225			kg	Fresh water	
	Output	Emission	H2S	0.000232			kg	Air	
	Output	Emission	H2S	0.00929			kg	Air	
	Output	Emission	H-3	242			kBq	Fresh water	
	Output	Emission	H-3	28.6			kBq	Air	
	Output	Emission	H-3	6590			kBq	Sea water	
	Output	Emission	HCFC-21	0.0000455			kg	Air	
	Output	Emission	HCFC-22	0.000000337			kg	Air	
	Output	Emission	HCl	0.00683			kg	Air	
	Output	Emission	HCl	0.0434			kg	Air	
	Output	Emission	He	0.000673			kg	Air	
	Output	Emission	He	0.00449			kg	Air	
	Output	Emission	Heat	0.000013			TJ	Ground	
	Output	Emission	Heat	0.0000464			TJ	Sea water	
	Output	Emission	Heat	0.000457			TJ	Air	
	Output	Emission	Heat	0.00626			TJ	Air	
	Output	Emission	Heat	0.0254			TJ	Air	
	Output	Emission	Heat	-1.02			TJ	Fresh water	
	Output	Emission	Heptane	0.00138			kg	Air	
	Output	Emission	Hexachlorobenzene	2.52E-10			kg	Air	
	Output	Emission	Hexachloroethane	6.06E-11			kg	Fresh water	
	Output	Emission	Hexafluoroethane	0.0000273			kg	Air	
	Output	Emission	Hexane	0.0029			kg	Air	
	Output	Emission	HF	0.00168			kg	Air	
	Output	Emission	HF	0.00523			kg	Air	
	Output	Emission	HFC-134a	3.88E-17			kg	Air	
	Output	Emission	Hg	0.00000874			kg	Fresh water	
	Output	Emission	Hg	0.00000915			kg	Air	
	Output	Emission	Hg	0.0000309			kg	Air	
	Output	Emission	Hg	2.02E-08			kg	Ground	
	Output	Emission	Hg	2.11E-08			kg	Sea water	
	Output	Emission	Hg	8.92E-08			kg	Air	
	Output	Emission	HOCl	0.000142			kg	Sea water	
	Output	Emission	HOCl	0.000588			kg	Fresh water	
	Output	Emission	Hydrocarbons	0.0000439			kg	Fresh water	
	Output	Emission	I	0.00000262			kg	Air	
	Output	Emission	I	0.0000418			kg	Fresh water	
	Output	Emission	I	0.00012			kg	Air	
	Output	Emission	I	0.00033			kg	Sea water	
	Output	Emission	I-129	0.00988			kBq	Air	
	Output	Emission	I-129	0.659			kBq	Sea water	
	Output	Emission	I-131	0.000447			kBq	Fresh water	
	Output	Emission	I-131	0.00114			kBq	Air	
	Output	Emission	I-133	0.000117			kBq	Fresh water	
	Output	Emission	I-133	0.000612			kBq	Air	
	Output	Emission	I-135	0.000916			kBq	Air	
	Output	Emission	K	0.000516			kg	Air	
	Output	Emission	K	0.0143			kg	Sea water	
	Output	Emission	K	0.0307			kg	Air	
	Output	Emission	K	0.145			kg	Fresh water	
	Output	Emission	K-40	0.00616			kBq	Air	
	Output	Emission	K-40	0.0169			kBq	Fresh water	
	Output	Emission	Kr-85	170000			kBq	Air	
	Output	Emission	Kr-85m	0.217			kBq	Air	
	Output	Emission	Kr-87	0.0945			kBq	Air	
	Output	Emission	Kr-88	8			kBq	Air	
	Output	Emission	Kr-89	0.068			kBq	Air	
	Output	Emission	La	0.000000472			kg	Air	

		Output	Emission	La	0.00000178			kg	Air	
		Output	Emission	La-140	0.0000046			kBq	Air	
		Output	Emission	La-140	0.00000531			kBq	Fresh water	
		Output	Emission	Methanol	0.000235			kg	Air	
		Output	Emission	Methyl Tertiary Butyl Ether	0.000000912			kg	Air	
		Output	Emission	Methyl Tertiary Butyl Ether	2.76E-08			kg	Sea water	
		Output	Emission	Methyl Tertiary Butyl Ether	4.78E-08			kg	Fresh water	
		Output	Emission	Mg	0.000763			kg	Air	
		Output	Emission	Mg	0.00142			kg	Air	
		Output	Emission	Mg	0.00213			kg	Sea water	
		Output	Emission	Mg	0.384			kg	Fresh water	
		Output	Emission	Mn	0.0000402			kg	Air	
		Output	Emission	Mn	0.000184			kg	Sea water	
		Output	Emission	Mn	0.000185			kg	Ground	
		Output	Emission	Mn	0.00816			kg	Air	
		Output	Emission	Mn	0.00995			kg	Fresh water	
		Output	Emission	Mn-54	0.00000188			kBq	Air	
		Output	Emission	Mn-54	0.000972			kBq	Fresh water	
		Output	Emission	Mn-54	0.154			kBq	Sea water	
		Output	Emission	Mo	0.00000014			kg	Air	
		Output	Emission	Mo	0.00000107			kg	Sea water	
		Output	Emission	Mo	0.00000244			kg	Air	
		Output	Emission	Mo	0.0000113			kg	Air	
		Output	Emission	Mo	0.00129			kg	Fresh water	
		Output	Emission	Mo-99	0.00000179			kBq	Fresh water	
		Output	Emission	N	0.0000106			kg	Ground	
		Output	Emission	N total	0.00229			kg	Sea water	
		Output	Emission	N total	0.00474			kg	Fresh water	
		Output	Emission	N2	0.00413			kg	Air	
		Output	Emission	N2O	0.00169			kg	Air	
		Output	Emission	N2O	0.00593			kg	Air	
		Output	Emission	N2O	0.00774			kg	Air	
		Output	Emission	Na	0.0000472			kg	Air	
		Output	Emission	Na	0.000156			kg	Air	
		Output	Emission	Na	0.000732			kg	Air	
		Output	Emission	Na	0.721			kg	Fresh water	
		Output	Emission	Na	1.03			kg	Sea water	
		Output	Emission	Na-24	0.00079			kBq	Fresh water	
		Output	Emission	Nb-95	0.000000333			kBq	Air	
		Output	Emission	Nb-95	0.0000146			kBq	Fresh water	
		Output	Emission	NH3	0.000381			kg	Air	
		Output	Emission	NH3	0.00522			kg	Air	
		Output	Emission	NH4+ as N	0.00172			kg	Sea water	
		Output	Emission	NH4+ as N	0.00939			kg	Fresh water	
		Output	Emission	Ni	0.000000758			kg	Ground	
		Output	Emission	Ni	0.00000774			kg	Sea water	
		Output	Emission	Ni	0.000152			kg	Air	
		Output	Emission	Ni	0.000293			kg	Air	
		Output	Emission	Ni	0.0012			kg	Air	
		Output	Emission	Ni	0.00259			kg	Fresh water	
		Output	Emission	NMVOC	0.0284			kg	Air	
		Output	Emission	NMVOC	0.22			kg	Air	
		Output	Emission	NMVOC	0.649			kg	Air	
		Output	Emission	NO2-	0.00000396			kg	Fresh water	
		Output	Emission	NO2-	0.000176			kg	Sea water	
		Output	Emission	NO3-	0.000877			kg	Sea water	
		Output	Emission	NO3-	0.00683			kg	Fresh water	
		Output	Emission	Noble gases (radioactive)	0.271			kBq	Air	
		Output	Emission	NOx	0.107			kg	Air	
		Output	Emission	NOx	0.379			kg	Air	
		Output	Emission	NOx	2.71			kg	Air	
		Output	Emission	Np-237	0.000291			kBq	Sea water	
		Output	Emission	Np-237	1.81E-09			kBq	Air	
		Output	Emission	Nuclide mix	0.00000992			kBq	Fresh water	
		Output	Emission	Oil	0.0000463			kg	Ground	

	Output	Emission	Oil	0.00302			kg	Fresh water	
	Output	Emission	Oil	0.0682			kg	Sea water	
	Output	Emission	Organic N	0.000335			kg	Sea water	
	Output	Emission	Organic N	0.000597			kg	Fresh water	
	Output	Emission	P	0.00000566			kg	Air	
	Output	Emission	P	0.0000178			kg	Air	
	Output	Emission	P	0.0000527			kg	Air	
	Output	Emission	P	0.000272			kg	Ground	
	Output	Emission	P	0.00328			kg	Ground	
	Output	Emission	Pa-234m	0.0011			kBq	Air	
	Output	Emission	Pa-234m	0.0204			kBq	Fresh water	
	Output	Emission	PAH	0.000000259			kg	Air	
	Output	Emission	PAH	0.0000201			kg	Fresh water	
	Output	Emission	PAH	0.0000429			kg	Sea water	
	Output	Emission	PAH	0.0000821			kg	Air	
	Output	Emission	Particles	0.0222			kg	Air	
	Output	Emission	Particles	0.267			kg	Air	
	Output	Emission	Particles	1.8			kg	Air	
	Output	Emission	Pb	0.0000011			kg	Sea water	
	Output	Emission	Pb	0.00000231			kg	Ground	
	Output	Emission	Pb	0.000237			kg	Air	
	Output	Emission	Pb	0.000479			kg	Air	
	Output	Emission	Pb	0.000551			kg	Air	
	Output	Emission	Pb	0.00572			kg	Fresh water	
	Output	Emission	Pb-210	0.0122			kBq	Air	
	Output	Emission	Pb-210	0.0134			kBq	Fresh water	
	Output	Emission	Pb-210	0.0217			kBq	Air	
	Output	Emission	Pentachlorobenzene	6.73E-10			kg	Air	
	Output	Emission	Pentachlorophenol	1.09E-10			kg	Air	
	Output	Emission	Pentane	0.00085			kg	Air	
	Output	Emission	Pentane	0.00731			kg	Air	
	Output	Emission	Phenol	0.00000125			kg	Air	
	Output	Emission	Phenol	0.000382			kg	Sea water	
	Output	Emission	Phenol	0.00103			kg	Fresh water	
	Output	Emission	Phosphoric compound	0.00000349			kg	Fresh water	
	Output	Emission	Pm-147	0.000933			kBq	Air	
	Output	Emission	Po-210	0.0122			kBq	Air	
	Output	Emission	Po-210	0.0134			kBq	Fresh water	
	Output	Emission	Po-210	0.0396			kBq	Air	
	Output	Emission	PO43-	0.0000107			kg	Sea water	
	Output	Emission	PO43-	0.029			kg	Fresh water	
	Output	Emission	Propane	0.000676			kg	Air	
	Output	Emission	Propane	0.00642			kg	Air	
	Output	Emission	Propene	0.000201			kg	Air	
	Output	Emission	Propene	0.000299			kg	Air	
	Output	Emission	Propionic acid	0.00000764			kg	Air	
	Output	Emission	Propionic aldehyde	2.26E-08			kg	Air	
	Output	Emission	Pt	5.19E-08			kg	Air	
	Output	Emission	Pu alpha	0.00011			kBq	Air	
	Output	Emission	Pu alpha	0.0181			kBq	Sea water	
	Output	Emission	Pu-238	4.1E-09			kBq	Air	
	Output	Emission	Pu-241 beta	0.00302			kBq	Air	
	Output	Emission	Pu-241 beta	0.45			kBq	Sea water	
	Output	Emission	Ra-224	0.0209			kBq	Fresh water	
	Output	Emission	Ra-224	0.165			kBq	Sea water	
	Output	Emission	Ra-226	0.00559			kBq	Air	
	Output	Emission	Ra-226	0.0345			kBq	Air	
	Output	Emission	Ra-226	0.33			kBq	Sea water	
	Output	Emission	Ra-226	83.9			kBq	Fresh water	
	Output	Emission	Ra-228	0.00303			kBq	Air	
	Output	Emission	Ra-228	0.0418			kBq	Fresh water	
	Output	Emission	Ra-228	0.33			kBq	Sea water	
	Output	Emission	Rb	0.00000431			kg	Fresh water	
	Output	Emission	Rb	0.000033			kg	Sea water	
	Output	Emission	Rn-220	0.257			kBq	Air	

	Output	Emission	Rn-222	0.936			kBq	Air	
	Output	Emission	Rn-222	2660			kBq	Air	
	Output	Emission	Rn-222 (long term)	244000			kBq	Air	
	Output	Emission	Ru-103	0.000000019			kBq	Air	
	Output	Emission	Ru-103	0.00000859			kBq	Fresh water	
	Output	Emission	Ru-106	0.011			kBq	Air	
	Output	Emission	Ru-106	1.1			kBq	Sea water	
	Output	Emission	S	0.00278			kg	Ground	
	Output	Emission	S2-	0.0000427			kg	Sea water	
	Output	Emission	S2-	0.0000949			kg	Fresh water	
	Output	Emission	Salt	0.263			kg	Fresh water	
	Output	Emission	Sb	0.0000033			kg	Air	
	Output	Emission	Sb	0.0000111			kg	Fresh water	
	Output	Emission	Sb	5.15E-08			kg	Air	
	Output	Emission	Sb-122	0.0000256			kBq	Fresh water	
	Output	Emission	Sb-124	0.000000509			kBq	Air	
	Output	Emission	Sb-124	0.00329			kBq	Fresh water	
	Output	Emission	Sb-125	0.000209			kBq	Fresh water	
	Output	Emission	Sb-125	6.86E-08			kBq	Air	
	Output	Emission	Sc	0.000000186			kg	Air	
	Output	Emission	Sc	0.000000595			kg	Air	
	Output	Emission	Se	0.000000892			kg	Air	
	Output	Emission	Se	0.0000011			kg	Sea water	
	Output	Emission	Se	0.0000374			kg	Air	
	Output	Emission	Se	0.000498			kg	Air	
	Output	Emission	Se	0.00237			kg	Fresh water	
	Output	Emission	Si	0.0000264			kg	Air	
	Output	Emission	Si	0.0000679			kg	Fresh water	
	Output	Emission	Si	0.00117			kg	Air	
	Output	Emission	Si	0.0132			kg	Air	
	Output	Emission	Sn	0.000000885			kg	Fresh water	
	Output	Emission	Sn	0.00000122			kg	Air	
	Output	Emission	Sn	9.45E-08			kg	Air	
	Output	Emission	SO2	0.339			kg	Air	
	Output	Emission	SO2	0.966			kg	Air	
	Output	Emission	SO2	1.56			kg	Air	
	Output	Emission	SO32-	0.000106			kg	Fresh water	
	Output	Emission	SO42-	0.0268			kg	Sea water	
	Output	Emission	SO42-	2.65			kg	Fresh water	
	Output	Emission	Sr	0.00000945			kg	Air	
	Output	Emission	Sr	0.0000675			kg	Air	
	Output	Emission	Sr	0.00825			kg	Fresh water	
	Output	Emission	Sr	0.0199			kg	Sea water	
	Output	Emission	Sr-89	0.00000329			kBq	Air	
	Output	Emission	Sr-89	0.000058			kBq	Fresh water	
	Output	Emission	Sr-90	0.0000214			kBq	Fresh water	
	Output	Emission	Sr-90	0.00181			kBq	Air	
	Output	Emission	Sr-90	0.22			kBq	Sea water	
	Output	Emission	Suspended solids	0.0769			kg	Fresh water	
	Output	Emission	Suspended solids	0.214			kg	Sea water	
	Output	Emission	Tc-99	0.115			kBq	Sea water	
	Output	Emission	Tc-99	7.69E-08			kBq	Air	
	Output	Emission	Tc-99m	0.0000121			kBq	Fresh water	
	Output	Emission	Te-123	0.00000108			kBq	Fresh water	
	Output	Emission	Te-123m	0.00000825			kBq	Air	
	Output	Emission	Te-132	0.000000443			kBq	Fresh water	
	Output	Emission	Tetrachloroethene	7.2E-09			kg	Fresh water	
	Output	Emission	Tetrachloromethane	0.000000011			kg	Fresh water	
	Output	Emission	Tetrachloromethane	0.00000137			kg	Air	
	Output	Emission	Tetrafluoromethane	0.000245			kg	Air	
	Output	Emission	Th	0.000000186			kg	Air	
	Output	Emission	Th	0.00000115			kg	Air	
	Output	Emission	Th-228	0.00256			kBq	Air	
	Output	Emission	Th-228	0.0836			kBq	Fresh water	
	Output	Emission	Th-228	0.66			kBq	Sea water	

	Output	Emission	Th-230	0.0122			kBq	Air	
	Output	Emission	Th-230	3.18			kBq	Fresh water	
	Output	Emission	Th-232	0.00163			kBq	Air	
	Output	Emission	Th-232	0.00314			kBq	Fresh water	
	Output	Emission	Th-234	0.0011			kBq	Air	
	Output	Emission	Th-234	0.0205			kBq	Fresh water	
	Output	Emission	Ti	0.0000286			kg	Air	
	Output	Emission	Ti	0.000176			kg	Air	
	Output	Emission	Ti	0.0282			kg	Fresh water	
	Output	Emission	Tl	0.000000457			kg	Air	
	Output	Emission	Tl	4.72E-08			kg	Air	
	Output	Emission	Toluene	0.0000501			kg	Fresh water	
	Output	Emission	Toluene	0.000311			kg	Air	
	Output	Emission	Toluene	0.000356			kg	Sea water	
	Output	Emission	Toluene	0.000855			kg	Air	
	Output	Emission	Total organic carbon	0.00204			kg	Fresh water	
	Output	Emission	Total organic carbon	0.0168			kg	Sea water	
	Output	Emission	Total organic carbon	0.0232			kg	Sea water	
	Output	Emission	Total organic carbon	0.101			kg	Fresh water	
	Output	Emission	Tributyltin	0.0000208			kg	Sea water	
	Output	Emission	Trichloroethene	0.000000455			kg	Fresh water	
	Output	Emission	Trichloromethane	0.00000014			kg	Air	
	Output	Emission	Trichloromethane	0.00000167			kg	Fresh water	
	Output	Emission	Triethylene glycol	0.0000475			kg	Sea water	
	Output	Emission	Triethylene glycol	0.000178			kg	Fresh water	
	Output	Emission	U	0.00000128			kg	Air	
	Output	Emission	U	9.45E-08			kg	Air	
	Output	Emission	U alpha	0.00379			kBq	Sea water	
	Output	Emission	U alpha	0.0394			kBq	Air	
	Output	Emission	U alpha	1.33			kBq	Fresh water	
	Output	Emission	U-234	0.0132			kBq	Air	
	Output	Emission	U-234	0.0272			kBq	Fresh water	
	Output	Emission	U-235	0.000638			kBq	Air	
	Output	Emission	U-235	0.0405			kBq	Fresh water	
	Output	Emission	U-238	0.00466			kBq	Air	
	Output	Emission	U-238	0.013			kBq	Air	
	Output	Emission	U-238	0.069			kBq	Fresh water	
	Output	Emission	V	0.00000107			kg	Sea water	
	Output	Emission	V	0.0000237			kg	Air	
	Output	Emission	V	0.000404			kg	Air	
	Output	Emission	V	0.000991			kg	Air	
	Output	Emission	V	0.00239			kg	Fresh water	
	Output	Emission	W	0.00000465			kg	Fresh water	
	Output	Emission	Vinyl chloride	0.000000864			kg	Air	
	Output	Emission	Vinyl chloride	2.04E-09			kg	Fresh water	
	Output	Emission	VOC	0.000146			kg	Fresh water	
	Output	Emission	VOC	0.00115			kg	Sea water	
	Output	Emission	Xe-121m	0.436			kBq	Air	
	Output	Emission	Xe-133	122			kBq	Air	
	Output	Emission	Xe-133m	0.0612			kBq	Air	
	Output	Emission	Xe-135	21.1			kBq	Air	
	Output	Emission	Xe-135m	2.2			kBq	Air	
	Output	Emission	Xe-137	0.0539			kBq	Air	
	Output	Emission	Xe-138	0.598			kBq	Air	
	Output	Emission	Xylene	0.0000419			kg	Fresh water	
	Output	Emission	Xylene	0.00031			kg	Sea water	
	Output	Emission	Xylol	0.00089			kg	Air	
	Output	Emission	Xylol	0.00122			kg	Air	
	Output	Emission	Y-90	0.00000296			kBq	Fresh water	
	Output	Emission	Zn	0.0000107			kg	Sea water	
	Output	Emission	Zn	0.0000744			kg	Ground	
	Output	Emission	Zn	0.000501			kg	Air	
	Output	Emission	Zn	0.00152			kg	Air	
	Output	Emission	Zn	0.00303			kg	Air	
	Output	Emission	Zn	0.00649			kg	Fresh water	

	Output	Emission	Zn-65	0.00000814			kBq	Air	
	Output	Emission	Zn-65	0.00167			kBq	Fresh water	
	Output	Emission	Zr	0.00000229			kg	Air	
	Output	Emission	Zr-95	0.00000012			kBq	Air	
	Output	Emission	Zr-95	0.00000354			kBq	Fresh water	
	Output	Emission	Zr-95	0.00933			kBq	Sea water	
	Output	Product	Electricity	1			TJ	Technosphere	
	Output	Residue	Hazardous waste	0.685			kg	Technosphere	
	Output	Residue	Highly radioactive waste	0.0000198			kg	Technosphere	
	Output	Residue	Inert waste deposit	5660			kg	Technosphere	
	Output	Residue	Low radioactive waste	0.000000769			kg	Technosphere	
	Output	Residue	Medium and low radioactive waste	0.00000941			kg	Technosphere	
	Output	Residue	Reactive waste deposit	0.139			kg	Technosphere	
	Output	Residue	Waste deposit	12.2			kg	Technosphere	
	Output	Residue	Waste in land farming	0.487			kg	Technosphere	
	Output	Residue	Waste to incineration	0.242			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www. energieforschung.ch -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their lifecycles. The results can be used in lifecycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans.
Detailed Purpose	ETH:s aim was to examine some important aspects of the environmental impact of hydro power plants in the UCPTE. The consumption of cement, steel, explosives and energyware during the construction phase is considered as well as transports, usable content of storages and the amount of water passing the turbines. Plants with and without storages are studied.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	The LCI-results of the three types of plants studied in the ETH study are valid for hydro power in Switzerland but are supposed to be a rather good approximation for hydro power in UCPTE. The two types, hydro power plants with and without storage, have been summarized to one set of data ''Hydro Power in UCPTE'' in accordance with existing percentages of those types of plants in the UCPTE region. Only this aggregated set of data is reported here. The result of the third type of hydro power plant is reported under the name ''Hydro Power with pumped storage in UCPTE'' in ETH's study (this kind of power plant is used to convert base load to peak load electricity with an efficiency of about 70%).
About Data	Only the most important construction materials have been inventoried as well as transports and energyware consumption during the construction phase, i.e. consumption of copper, concrete additives or possible recycling processes of scrapped material etc. have been excluded. Data quality regarding inventoried material and energyware amounts is high, since the sources are reliable. The division of the steel consumption in the three different steel qualities has however been estimated. Due to difficulties in finding detailed data regarding the construction of studied plants (some data has been estimated) the results should be seen as approximate. Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided).

	Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Publication, Notes and General metadata.
Notes	Reviewer of this specification of metadata describing the ETH study has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut

SPINE LCI dataset: Hydro-electric power station with support systems

Administrative	
Finished	Y
Date Completed	1996-12-01
Copyright	
Availability	Public

Technical System	
Name	Hydro-electric power station with support systems
Functional Unit	Net production of 1 kWh electricity
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the production of 1 kWh electricity.
Process Type	Cradle to gate
Site	Vattenfall - Lule river
Sector	Grid electricity and district heat
Owner	Vattenfall - Lule river
Technical system description	The environmental influence of *operation and maintenance of a hydro-electric power station* are included in the system. Production of materials and chemicals and transports used in association with the operation and maintenance are included. To represent the hydro-electric power plants of Vattenfall, three hydro-electric power plants in river Lule have been studied: • *Seitevare with Tjaktjajaure annual storage basin*, located in a mountain region -an under ground station, with an effect of 214 MW and normal annual production 799 GWh. The basin is filled during the spring, summer and fall and generally tapped between October and April • *Harsprånget* has a large river flow and high drop, and is located in a forest region - under ground plant, with an effect of 940 MW and normal annual

	production 2159 GWh. The plant has five units. • *Boden* has only part of the river flow and medium drop, and is located in a coastal region - an above ground plant, with an effect of t 80 MW and normal annual production 464 GWh. Vattenfall has about 70 wholly-owned and 70 part-owned hydro-electric power stations in Sweden. The electricity production primarily affect river Lule, river Skellefte, river Ume, Ångermanälven, Indalsälven, Dalälven, Motala stream and river Göta. During a normal year, the electricity production in Vattenfall:s plants are 32 TWh, which is about 50 % of the total electricity production by water power in Sweden. All hydro-electric power electricity production are based on two fundamental conditions: water supply and drop. More water and greater drop gives a larger electricity production. The water supply varies during the year, and to use the availalble water supply during the year, reservoirs and power stations are built along the watercourse.

System Boundaries	
Nature Boundary	The analysis starts at one of the water storage basins and then the river are followed through the power plants and dams, tunnels, machine stations and outlets to the outlet into the sea. Flows above the storage basin have been excluded because the environmental effect of the expansion (utbyggnad) above the annual storage facilities are considered to be a small. All emissions are considered equivalent independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The power plant are assumed to operate during 60 years. The power plants can however operate longer than that. The probability that the power stations will ever be demolished are small.
Geographical Boundary	The analysis are divided into three systems. The three systems represent three representative power stations in river Lule; Seitevare with Tjaktjajaure annual storage basin, Harsprånget and Boden.
Other Boundaries	The studied system include *operation and maintenance of the power plant.* Calculations of building and demolition of the plant has been performed but are not included in this system. ***Sub-systems included in the system:*** • Manufacture and transport of materials for reinvestments and reconstruction • Transports of operation personnel • Known use of chemicals are accounted for. In the cases where it was possible to obtain data, resource use and emissions for manufacture are included. • Use of resources and emissions to air from production of the electricity used in the life cycles. • Energy use and emissions for the production of oil for the studied manufacturing processes and transports. ***Sub-systems excluded from the system:*** • Equipment after the power station transformer are not included. • Emissions at ordinary occurring operation disturbances have only been studied for water power and have been included when the emissions from the operation disturbance are at least 10% of the corresponding emissions from building and normal operation of the water power station.

	• The risk of major accidents and rare breakdowns and environmental consequences from these. • Waste and rest products are transported to final waste. Operation and chemical and biological decomposing processes (nedbrytningsprocesser) in the final waste have not been considered. • Work environment. • Environmental loads caused by the operation personnel.
Allocations	The *50/50 method* has been applied throughout the analysis. The method is described in ''Nordic Guidelines on Life-Cycle Assessment'', Nord 1995:20, The Nordic Council, Stockholm.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	Average hydro power in the UCTPE countries (except pumped storage used for daily regulation of power production)
Method	An LCA calculation on the operation of a water power plant
Literature Reference	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', in Swedish, Vattenfall AB
Notes	Note: The unit for CO is corrected, from g to mg (2000-08-17). The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate. Emissions of NOx, CO2, CO and SO2 originate primarily from transports in association with operation and maintenance. The choice of power plants in river Lule gives long transport distances. Production of materials also causes relatively large emissions of SO2 and CO2.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: ''Överdämd'' and damaged land and land for the building area is included. Land for extraction of resources and final waste (deponi) etc. are not included.	Input	Natural resource	Area	.000358			m2	Ground	
	Input	Natural resource	Bio fuel	0.000000498			kWh	Other	
	Input	Natural resource	Coal	.000101			kWh	Other	
	Input	Natural resource	Copper ore	62.100000			mg	Ground	
	Input	Natural resource	Iron ore	29.400000			mg	Ground	
	Input	Natural resource	Lead ore	19.700000			mg	Ground	
Notes: Electricity produced by nuclear power. To produce 1 kWh electricity in a nuclear power plant, 1,24 gram of uranium ore is used.	Input	Refined resource	Electricity	.000004			kWh	Technosphere	
Notes: Electricity produced by hydro power.	Input	Refined resource	Electricity	.000005			kWh	Technosphere	
Notes: Have not been traced back to the cradle.	Input	Refined resource	H2SO4	.327000			mg	Technosphere	
Notes: The figure includes oil, gasoline, diesel, lubricating- and transformer oil	Input	Refined resource	Heavy oil	.000070			kWh	Technosphere	
	Input	Refined resource	Natural gas	.000003			kWh	Technosphere	
Notes: Note: The unit for CO is corrected, from g to mg (2000-08-17). There are gaps of data for e.g. production of copper lead and cement.	Output	Emission	CO	1.800000			g	Air	

	Output	Emission	CO_2	67.700000			mg	Air	
Notes: Reports the total amount of HC. There are datagaps for e.g. production of copper, lead and cement.	Output	Emission	HC	.247000			mg	Air	
	Output	Emission	NO_x	.263000			mg	Air	
Notes: There are gaps of data for e.g. the production of copper, lead, cement and lubricating oil	Output	Emission	N-tot	.321000			ug	Water	
Notes: There are gaps of data for production of e.g. lubricating oil, explosives and personal transports.	Output	Emission	Particles	29.500000			ug	Air	
	Output	Emission	SO_2	.109000			mg	Air	
	Output	Product	Electricity	1.000000			kWh	Technosphere	
Notes: Includes rest products from manufacture of materials, exchanged material and earth to final waste (deponi). Includes also fully operational power plants. They leave the system after the studied time of 60 years. There are some data gaps.	Output	Residue	Other rest products	89.4			g	Technosphere	

About Inventory	
Publication	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	The data can be used as a basi
General Purpose	• The work with life-cycle analysis are expected to *contribute to a reinforcement and structuring* of the environmental work within Vattenfall, and a deeper knowledge on the use of resources and emissions to the environment. • An LCA can *facilitate a need for reliable data for electricity production.* Electricity is used in the manufacture of almost every product, and data from an LCA can be used when conducting an LCA on products. • An LCA can *facilitate a choice between different techniques* for future electricity production. • An LCA can also help to *choose the most effective alternatives* to reduce the consumption of resources and environmental influence of the current electricity production system. • It is also possible to *compare* the environmental load for different alternatives of electricity production.
Detailed Purpose	To obtain a *reliable basis* to be able to perform life-cycle analyses of different types of electricity use, and to identify opportunities for improvements in the existing system. To identify data gaps and areas where the knowledge are poor.
Commissioner	- Vattenfall Elproduktion .
Practitioner	- Vattenfall Energisystem AB: Britt-Marie Brännström-Norberg Ulrika Dethlefsen Roland Johansson Caroline Setterwall Sofie Tunbrant .
Reviewer	- Thomas Ekvall, Chalmers Industriteknik (CIT) Gunnar Lindfors, Institutet för Vatten- och Luftvårdsforskning (IVL) Göran Finnveden, Institutet för Vatten- och Luftvårdsforskning (IVL)
Applicability	The studied system include operation and maintenance of a hydro-electric power plant. The analysis are based on data from three hydro-electric power plants in river Lule that are chosen to make the analysis *representative for the operation of Vattenfall:s plants.* There are differences between the three power stations. The differences are however not larger than an average value should be representative for the water power along the entire river Lule. The data are reliable since specific plants have been studied. The consequence is however that the result is primarily valid for the studied plants. Thoroughly reliable data for every power source, requires life cycle analyses for a large number of power plants for every power source. Nuclear and water power are the base for Vattenfall:s electricity production system. Vattenfall produces 50 % of the

	electricity produced by water power in Sweden. River Lule has been chosen in the analysis because: • River Lule generates the most electricity, approximately 50% of Vattenfall:s water power production and 1/9 of the entire electricity production of Sweden. • There are annual storage basins in river Lule, which makes it possible to adjust the tapping from a annual storage basin to the variations in water supply from one year to another. • Parts of river Lule are expanded for power, which means that the tapping of water are adjusted to the need of temporary effect increases. The consequence is a more extensive influence on the environment. The environmental influence will then not be underestimated. • Vattenfall is single owner which has made it easier to obtain data. Transmission and distribution losses are not included. When the result is used to study different types of electricity use, these losses should be included. A rough estimate are that the distribution losses for a large industry customer are approximately 5% of the bought electricity, i.e. to obtain data for the use of electricity the data should be multiplied with 1,05. For an average household customer the transmission losses are approximately 10% of the bought electricity, i.e. the data should be multiplied with 1,10. A large share of the *environmental influence associated with water power* are difficult to handle in a life cycle analysis. It is possible to make an inventory of the different types of influence, but difficult to assess quantitatively. The environmental influence are to a large extent direct and local, such as influence on the landscape and biological diversity. The complete study include building, operation and maintenance, and demolition of the power plant. When the data is used for energy production in a life cycle analysis of a product or a system, that do not require expansion of the electricity production system, it however reasonable only to include operation and maintenance. The other phases of the life cycle are the same independent on the electricity production.
About Data	Data for the *power stations are specific* for the respective plant. The reported data are weighted averages of the use of resources and energy for operation of three hydro-electric power plants in river Lule: Seitevare with Tjaktjajaure annual storage basin, Harsprånget and Boden. Relevant data for transports, extraction and production of metals and chemicals, and manufacture and work on important components were hard to obtain. Data from manufacturers and other reports and studies, primarily life cycle analyses have been used. Production of material and transports are considered with current technology. Swedish standard values have been used to calculate fuel use and emissions from transports. Transport distances are specific for the operation of the plant. *The parameters that are presented* are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate. Use of materials and chemicals for *operation and reinvestments* of the power plants are generally assumed to give an addition of 1 % per year of the use of resources and emissions at the building phase. Dams, concrete constructions and buildings are however not considered to need to renewal during the lifetime of the power station. The following data has been used in the analysis (tonnes per year during 60 years): Seitevare: Steel 9,43; Copper 0,38; Lead 0,5; Sulphuric acid 0,22 Harsprånget: Steel 71,3; Copper 3,1; Lead 1,17; Sulphuric acid 0,75 Boden: Steel 9,02; Copper 0,24; Lead 0,58; Sulphuric acid 0,26 For electricity used in the manufacture of materials and

		fuels, *average electricity* for the respective countries distributed on different electricity production alternatives have been used. The following *degrees of efficiencies* have been used to calculate the fuel used in the electricity production. The values are standard values for existing power plants. New modern plants have often higher degrees of efficiencies. The values are calculated from the effective heat value in the used fuels and the energy content in the steam produced in a nuclear power plant. • Coal condensing: 40% • Oil condensing: 40% • Natural gas condensing/combination: 40% • Gas turbine: 25% • Combined heat and power plant(irrespective of fuel) 30% (for electricity production) 85% (total for electricity and heat production) • Water power: are not recalculated, but are accounted for as kWh electricity • Nuclear power: 33%, are however not recalculated, but accounted for as kWh electricity or gram natural uranium.
	Notes	There are several known and possible environmental effects at expansion of water power that cannot be quantitatively described: • Influence on the landscape, and a large influence on the area near a regulation reservoir. • A loss of biological diversity, because of large differences in water level before and after the expansion. • Displacement in the population of species influence e.g. the fishing. • The transport of important minerals to the sea are changed. • Roads have been built in mountain regions, which have both positive and negative effects. • Loss of land, and damages to the earth for agriculture. • A more even water flow has reduced the risk of flooding. • Influence on the reindeer breeding because of loss of land, obstruction of movement of reindeer herds etc. To reduce the negative effects, actions like biotope improvements and preservation of some water flow in the river have been used. Today, there are approximately 1000 hydro-electric power plants in Sweden. Most of them are small, 10-100 kW. More than 120 power plants have an effect larger than 20 MW. About 50% of the electricity produced in Sweden is from water power. The remaining share are predominately nuclear power. Of the electricity produced by water power, about 50% are produced in Vattenfall:s plants. The probability that the power stations will ever be demolished are small. A water power plant has low costs and running reinvestments and reconstruction will be done.

SPINE LCI dataset: Hydrogen fuel production by steam reforming of natural gas. ESA-DBP

Administrative	
Finished	Y
Date Completed	2002
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Hydrogen fuel production by steam reforming of natural gas. ESA-DBP
Functional Unit	1 MJ of CGH2 (compressed hydrogen)
Functional Unit Explanation	Compressed hydrogen is the gaseous state of the element hydrogen which is kept under pressure. It can be used for mobile hydrogen storage in hydrogen vehicles. It is assumed that the final pressure of the hydrogen gas stored is 250 bar.
Process Type	Cradle to gate
Site	Unknown
Sector	Energyware
Owner	Unknown
Technical system description	Hydrogen can be used as an energy source for fuel cell vehicles. The fuel cell consists of 3 main elements: cathode, anode and electrolite. It can use hydrogen and oxygen to create electricity by an electro-chemical process. Excerpt from the report (see 'Publication'): ''Hydrogen can be produced from many different sources (fossil hydrocarbons, biomass or water) using different technologies such as electrolysis, steam reforming or gasification.(...) Steam reforming is the most common production process today and the most cost-effective. Normally natural gas is used as the feedstock(...). The energy efficiency is about 75-80% for large scale reforming. If the process is combined with and efficient waste recovery, 85% might be reached.'' During the process ''there will be energy losses in the reformer and compressor. However, since there is no need to compress the natural gas, the energy used for CNG (NB: compressed natural gas) pathway is reduced by 0.05MJ/MJ NG (NB: natural gas). The energy efficiency of the small-scale reformer is 79.8% based on LHV (NB: Lower Heating Value). (...) It is assumed that the final pressure of the hydrogen gas stored is 250 bar and the compression is done by NG-fuelled gas turbines (n=34%); the natural gas used is 0.14MJ/MJ compressed gas.'' There are 3 main steps of producing the hydrogen: 1. NG pathway (exploration, extraction, distribution) 2. Small scale reforming 3. Compression natural gas fuelled This process is included in the system described in: Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf Other processes in the CPM Database also included in the above publication: Hydrogen fuel production from on-site electrolysis. ESA-DBP Fuel cell bus run on hydrogen produced in steam reforming process. ESA-DBP Fuel cell bus run on hydrogen produced in electrolysis process. ESA-DBP

System Boundaries	
Nature Boundary	The performed study is cradle-to-gate and it relates to the hydrogen pathway 'well-to tank'. It covers the fuel pathway from feedstock to fuel dispenser nozzle.
Time Boundary	The data were acquired in 2002 as the most up-to-date ones. The data come from 2001.
Geographical Boundary	The study was performed for Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': ''The on-site production of hydrogen has been considered as the near term production option. The reference case of production is from steam reforming because it will probably be the most cost-effective production method. The size of the production facility of

	hydrogen is assumed 3.1 MW, which will be enough for a fleet of 100 buses.''
Allocations	Data were given for 1 MJ of hydrogen.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2001
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from other report
Literature Reference	Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2002--10.pdf The reference for specific inventory data for this process: Röder, A. (2001). Life Cycle Inventory and Costs of Different Car Powertrains. Villingen
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Resource	Natural gas	1.53E+00			MJ	Ground	Sweden
	Output	Emission	CH4	1.73E-02			g	Air	Sweden
	Output	Emission	CO2	8.56E+01			g	Air	Sweden
	Output	Emission	N2O	6.84E-04			g	Air	Sweden
	Output	Emission	NOx	3.07E-02			g	Air	Sweden
	Output	Emission	Particles	9.27E-04			g	Air	Sweden
Notes: Compressed hydrogen	Output	Product	CGH2	1.00E+00			MJ	Technosphere	Sweden

About Inventory

Publication	Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report (see 'Publication'): ''The main goal is an environmental assessment of the use of fuel cell buses on bus route 60 in Göteborg. Environmental assessments involve the gathering, evaluation and synthesize of data and methods using engineering and scientific research to help address an environmental decision making situation. This assessment is made to decide whether to invest in a new technology for fuel cell buses by 2006 or to rely on other bus technologies. (...) The main goal is divided into 3 parts. the first goal of this study is to describe the technical system, methodology used, and frame of the problem. In the future when real investment decision will be made, this study could then help frame an actual investment decision. The second goal is to present environmental performance results for the different alternative bus technologies. The results address emissions, health effects, and financial investments. The third goal is to describe and assess the uncertainties of the results.''
Detailed Purpose	Hydrogen is an energy source for a fuel cell and its production is presented in the reference report. Hydrogen production by steam reforming of a natural gas is the most cost-effective way of production. Determining the inventory data for this process is an important part of the study.
Commissioner	MISTRA - .
Practitioner	Karlström, Magnus - .
Reviewer	Steen, Bengt -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, the Division of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-

	Marie Tillman (ESA).
Notes	Hydrogen is an energy source for fuel cell. Fuel cell consists of 3 main parts: anode, cathode and electrolyte. Excerpt from the report, see 'Publication': ''An anode is an electrode where oxidation occurs. That is, the fuel, usually hydrogen, reacts in the anode. A cathode is an electrode where reduction occurs. That is, the oxidant, usually oxygen, reacts in the cathode. The third fundamental part is the electrolyte, which is an electrical conductor that carries current by the movement of ions. The combination of these three parts converts chemical energy into heat and electrical energy, which could be used for any electrical load. (...) A fuel cell reaction separates the oxidation at the anode and the reduction at the cathode with an electolyte, which allows the ions to move between the two electrodes.''

SPINE LCI dataset: Hydrogen fuel production from on-site electrolysis. ESA-DBP

Administrative	
Finished	Y
Date Completed	2002
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Hydrogen fuel production from on-site electrolysis. ESA-DBP
Functional Unit	1 MJ of CH2 (compressed hydrogen)
Functional Unit Explanation	Compressed hydrogen is the gaseous state of the element hydrogen which is kept under pressure. It can be used for mobile hydrogen storage in hydrogen vehicles.
Process Type	Gate to gate
Site	Unknown
Sector	Energyware
Owner	Unknown
Technical system description	Hydrogen can be used as an energy source for fuel cell vehicles. The fuel cell consists of 3 main elements: cathode, anode and electrolite. It uses hydrogen and oxygen to create electricity by an electro-chemical process. Excerpt from the report (see 'Publication'): ''Hydrogen can be produced from many different sources (fossil hydrocarbons, biomass or water) using different technologies such as electrolysis, steam reforming or gasification.(...) Hydrogen from electricity by electrolysis is one of the most well-known and simpliest methods to produce hydrogen.'' The first step of the process is delivering the electricity to the electrolyser. The electrolyser produces hydrogen with 30 bar of pressure. It is transfered to the compression electrical pumps where also some electricity (for producing 1 MJ of compressed hydrogen, 0.065MJ is needed for this stage) is provided. ''The energy efficiency of the electrolyser is 65.1% (LHV) (NB: LHV - Lower Heating Value), which means that 1/0.651=1.53MJ electricity is used per MJ H2. The electric pumps (n=50% for small plants) used to compress the hydrogen are use =0.0652 MJ Electricity/MJ CGH2. The total electricity demand per CGH2=1.536+9.0652=1.60MJ. The distribution loss of electricity is 6%. Then the demand is 1.60*1.06=1.697MJ electricity.'' This process is included in the system described in: Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf Other processes in the CPM Database also included in the above publication: Hydrogen fuel production by steam reforming of natural gas. ESA-DBP Fuel cell bus run on hydrogen produced in steam reforming process. ESA-DBP Fuel cell bus run on hydrogen produced in electrolysis process. ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It covers only electrolysis and compression.
Time Boundary	The data were acquired in 2002 as the most up-to-date ones. The data come from 2001.
Geographical Boundary	The study was performed for Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': ''The size of the electrolysis hydrogen plant is 3.1 MW, (...) which will be enough for a fleet of 100 buses. An advanced high-pressure electrolyzer is used for producing hydrogen.''
Allocations	Data were given for 1 MJ of hydrogen.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other report
Literature Reference	Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2002--10.pdf The reference for specific inventory data for this process: Röder, A. (2001). Life Cycle Inventory and Costs of Different Car Powertrains. Villingen
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Excerpt from the report, see 'Literature reference': ''The electric pumps (n=50% for small plants) used to compress the hydrogen are use =0.0652 MJ Electricity/MJ CGH2. The total electricity demand per CGH2=1.536+9.0652=1.60MJ. The distribution loss of electricity is 6%. Then the demand is 1.60*1.06=1.697MJ electricity.''	Input	Refined resource	Electricity	1.70E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Hydro (El.)	7.50E-01			MJ	Technosphere	Sweden
	Input	Resource	Crude oil	3.17E-02			MJ	Ground	Sweden
	Input	Resource	Hard coal	3.61E-03			MJ	Ground	
	Input	Resource	Natural gas	9.85E-04			MJ	Ground	Sweden
	Input	Resource	Uranium ore	2.84E-01			g	Ground	
	Input	Resource	Wood	1.50E-01			MJ	Ground	
	Output	Emission	CO2	1.27E+01			g	Air	Sweden
	Output	Emission	NOx	1.69E-02			g	Air	Sweden
	Output	Emission	Particles	2.88E-03			g	Air	Sweden
	Output	Product	CGH2	1			MJ	Technosphere	Sweden

About Inventory

Publication	Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report (see 'Publication'): ''The main goal is an environmental assessment of the use of fuel cell buses on bus route 60 in Göteborg. Environmental assessments involve the gathering, evaluation and synthesize of data and methods using engineering and scientific research to help address an environmental decision making situation. This assessment is made to decide whether to invest in a new technology for fuel cell buses by 2006 or to rely on other bus technologies. (...) The main goal is divided into 3 parts. the first goal of this study is to describe the technical system, methodology used, and frame of the problem. In the future when real

	investment decision will be made, this study could then help frame an actual investment decision. The second goal is to present environmental performance results for the different alternative bus technologies. The results address emissions, health effects, and financial investments. The third goal is to describe and assess the uncertainties of the results.
Detailed Purpose	Hydrogen is an energy source for fuel cell and its production is presented in the reference report. Hydrogen production from electrolysis is one of few ways of producing the hydrogen. Determining the inventory data for this process is an important part of the study.
Commissioner	MISTRA - .
Practitioner	Karlström, Magnus - .
Reviewer	Steen, Bengt -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, the Division of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Hydrogen is an energy source for fuel cell. Fuel cell consists of 3 main parts: anode, cathode and electrolyte. Excerpt from the report, see 'Publication': ''An anode is an electrode where oxidation occurs. That is, the fuel, usually hydrogen, reacts in the anode. A cathode is an electrode where reduction occurs. That is, the oxidant, usually oxygen, reacts in the cathode. The third fundamental part is the electrolyte, which is an electrical conductor that carries current by the movement of ions. The combination of these three parts converts chemical energy into heat and electrical energy, which could be used for any electrical load. (...) A fuel cell reaction separates the oxidation at the anode and the reduction at the cathode with an electolyte, which allows the ions to move between the two electrodes. (...) Hydrogen from electricity by electrolysis is one of the most well-known and simpliest methods to produce hydrogen. Only electricity and pure water is needed to produce extremely pure hydrogen. However only about 4% of the hydrogen produced today in the world is from electrolysis. (...). The major problem with electrolysis is the high cost of electricity when compared with steam reforming of natural gas in most countries. However there are benefits such as its flexibility, simplicity, reliability and purity of the product. Furthermore, the plant is locally non-polluting in itself and if the electricity is made from renewable source, such as hydropower, solar energy, or wind energy, then the potential for reduction of greenhouse gases is substantial. The electrolysis technology is modular in its design, making it possible to design the process over a wide range of scales from a few kilowatts to hundreds of megawatts. Three different technologies for water electrolysis are available. They differ depending on what kind of electrolyte is used. The most common and the only commercial alternative today is based on alkaline technology using liquid KOH as electrolyte. (...) The electrolyzers normally have efficiency [hydrogen output (HHV)/electricity input) 70-85% (NB: HHV - Higher Heating Value).''

SPINE LCI dataset: Hydrotreated Vegetable Oil - Palm oil, cradle-to-gate, system expansion - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Hydrotreated Vegetable Oil - Palm oil, cradle-to-gate, system expansion - f3 fuels
Functional Unit	1 MJ

Functional Unit Explanation	1 MJ Hydrotreated Vegetable Oil - Palm oil
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	Production (cradle to gate) of Hydrotreated Vegetable Oil (HVO), produced from Palm oil. The data is based on several data sources (see References) and based on data sets for each process step. An LCA model has been complied within this f3 project (see Additional information). This data set is the result of this LCA model. Neste oil (Finland) produces HVO from palm oil, rape seed oil and from animal fat. The HVO sold on the market under the name NExBTL is a mix of HVO from these three raw materials. The mix varies, but in 2012 it was 64.5% from palm oil, 0.3% from rape seed, jathropa and camelina oil, as well as 35.1% from waste and residues (animal fat, waste fish processing fat, fatty acid from palm and stearin). The heat value for the HVO mix is 44.1 MJ/kg (4) and the average density is 780 kg/m3 (4 & 5). The LCA model was divided in three stages: agricultural stage, processing stage and HVO production. In every life cycle stage transportation is included. The LCA model includes direct affected processes, overhead (operation of buildings, administration, etc.) and capital goods (building, machinery and means of transportation). All electricity is assumed to be European average. Emissions of pesticides are assumed to be received by air (33%), soil (33%) and water (33%). Palm oil mill effluent (POME) is assumed to be treated in open anaerobic-aerobic ponds. Empty fruit bunches are applied as mulch in the plantation. The total amount of shells and fibers from palm fruits are assumed to be burned in boiler to produce steam and electricity. It is assumed that all palm kernel oil extraction takes place using mechanical extraction. The palm is grown, harvested and refined into crude oil in Malaysia. The fuel component is refined into the fuel product in Kilpilahti, Porvoo, Finland. Finally the fuel product is distributed to tank service stations in Finland. Ommited data: - The production of seeds during agricultural stage has been ommited; - Production of cypermethrin, warfarin and fungicides has been omitted; - Methane emissions from oil palm plantation have been ommited; - No capital goods or overhead for the HVO production facility is included in the model. - Chemicals used to treat POME are not accounted for. - Lubricating oil is ommited from the inventory of the processing stage.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	
Other Boundaries	
Allocations	No.
Systems Expansions	System expansion for by-products and energy replacing other products and other energy. Processing stage: palm kernel cake substituting soybean meal from Brazil; fibres and shells burned in boiler substituting electricity from the grid (data for European average grid (UCTE) have been used) and sand at mine. HVO production: biogasoline substituting naphtha; fuel gas substituting natural gas.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	Literature studies
Literature Reference	- Data for agriculture and palm oil processing (reference 1). - Data for hydrotreatment at Neste oil (reference 2 & 3). (1) Schmidt, J.H. (2007). Life cycle assessment of rapeseed oil and palm oil. Ph.D. thesis, Part 3: Life cycle inventory of rapeseed oil and palm oil. (2) Institute for Energy and Environmental Reseach Heidelberg GmbH - IFEU (2006). An Assessment of Energy and Greenhouse Gases of NExBTL. (3) Arvidsson, R. & Persson, S. (2008). Life Cycle Assessment of NExBTL from Rape, Oil Palm and Jatropha. Master's Thesis in Chemical Environmental Science. (4) Mikkonen, S. et al. (2012). HVO, Hydrotreated Vegetable Oil - A Premium Renewable Biofuel for Diesel Engines. Neste Oil Corporation, p. 15. (5) Neste oil: NExBTL renewable diesel, Product information, page 15.

Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Resource	Crude oil	2.25383676075082E-03			kg	Ground	
	Input	Resource	Hard coal	8.03977479449618E-04			kg	Ground	
	Input	Resource	Lignite	7.89850461524259E-04			kg	Ground	
	Input	Resource	Natural gas	3.70826423176749E-03			kg	Ground	
	Input	Resource	Uranium	3.58721219766039E-08			kg	Ground	
	Output	Emission	Ammonia	1.26322560610964E-04			kg	Air	
	Output	Emission	Ammonium / ammonia	1.71014657972799E-07			kg	Water	
	Output	Emission	Biological oxygen demand	2.0970010511014E-05			kg	Water	
	Output	Emission	Carbon dioxide (biogenic)	2.0004960432215E-04			kg	Air	
	Output	Emission	Carbon dioxide (fossil)	2.76693869213026E-02			kg	Air	
	Output	Emission	Carbon dioxide, land transformation	-9.53678813370999E-04			kg	Air	
	Output	Emission	Carbon monoxide (biogenic)	-2.23234075117344E-08			kg	Air	
	Output	Emission	Chemical oxygen demand	2.9517189738735E-05			kg	Water	
	Output	Emission	Hydrocarbons (unspecified)	3.18059976199871E-06			kg	Air	
	Output	Emission	Hydrogen sulfide	7.35573000299253E-06			kg	Air	
	Output	Emission	Methane (biogenic)	1.28175536229613E-08			kg	Air	
	Output	Emission	Methane (fossil)	1.19979326980311E-03			kg	Air	
	Output	Emission	Nitrate	2.29941307320657E-03			kg	Water	
	Output	Emission	Nitrate	3.56072445475342E-10			kg	Air	
	Output	Emission	Nitrogen monoxide	2.11456719491062E-05			kg	Air	
	Output	Emission	Nitrogen oxides	1.06681909671162E-04			kg	Air	
	Output	Emission	Nitrous oxide	6.70025453719786E-05			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	5.74962809370861E-06			kg	Air	
	Output	Emission	Particles (> PM10)	6.84956848214561E-06			kg	Air	
	Output	Emission	Particles (PM0.2 - PM2.5)	3.72579208222499E-06			kg	Air	
	Output	Emission	Particles (PM2.5)	2.08602729494019E-05			kg	Air	
	Output	Emission	Phosphate	1.20028451522569E-05			kg	Water	
	Output	Emission	Phosphorus	1.04447895320786E-05			kg	Water	
	Output	Emission	Phosphorus	7.8466706755725E-08			kg	Air	
	Output	Emission	Sulfur dioxide	8.05485663007552E-05			kg	Air	
	Output	Emission	Total dissolved organic bounded carbon	6.31534311091074E-06			kg	Water	
	Output	Emission	Total organic bounded carbon	6.39985601747588E-06			kg	Water	
	Output	Product	HVO - Palm oil	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Felipe Oliveria, IVL.
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	There are two well to tank data sets for HVO published within this f3 project; HVO from palm oil and rapeseed oil.

SPINE LCI dataset: Hydrotreated Vegetable Oil - Rapeseed oil, cradle-to-gate, system expansion - f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Hydrotreated Vegetable Oil - Rapeseed oil, cradle-to-gate, system expansion - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ Hydrotreated Vegetable Oil - Rapeseed oil
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	Production (cradle to gate) of Hydrotreated Vegetable Oil (HVO), produced from Rapeseed Oil. The data is based on several data sources (see References) and based on data sets for each process step. An LCA model has been complied within this f3 project (see Additional information). This data set is the result of this LCA model. Neste oil (Finland) produces HVO from palm oil, rapeseed oil and from animal fat. The HVO sold on the market under the name NExBTL is a mix of HVO from these three raw materials. The mix varies, but in 2012 it was 64.5% from palm oil, 0.3% from rapeseed, jathropa and camelina oil, as well as 35.1% from waste and residues (animal fat, waste fish processing fat, fatty acid from palm and stearin). The heat value for the HVO mix is 44.1 MJ/kg (4) and the average density is 780 kg/m3 (4 & 5). The LCA model was divided in three stages: agricultural stage, processing stage and HVO production. In every life cycle stage transportation is included. The LCA model includes direct affected processes, overhead (operation of buildings, administration, etc.) and capital goods (building, machinery and means of transportation). Electricity in agricultural and processing stages is assumed to be Danish production mix, while in HVO production stage it is assumed to be European average (UCTE mix). It is assumed that 87% of the straw is left on the field, and 13% is used for energy purposes. Emissions of pesticides are assumed to be received by air (33%), soil (33%) and water (33%). Emissions generated by burning of straw are assumed to be equivalent to burning of softwood in furnace. Rapeseed oil is extracted by utilization of hexane as solvent. Residual rapeseed from screening process of incoming rapeseed is sent to biogas production. The rapeseed is grown, harvested and refined into crude oil in Danmark. Data for processing stage refers to AarhusKarlshamn refinery, in Aarhus, Danmark. The fuel component is refined into the fuel product in Kilpilahti, Porvoo, Finland. Finally the fuel product is distributed to tank service stations in Finland. Ommited data: - Magnesium, sulphur and boron fertilisers are not taken into account; - Dust emissions and soil erosion are omitted; - No indirect NO emissions from the field are accounted for; - Lubricating oil and cleaning agents are omitted from processing stage; - Recycling of paper, plastic, metals, lubricating oil, as well as waste to landfill are omitted from processing stage; - No capital goods or overhead for the HVO production facility is included in the model.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	

Other Boundaries	
Allocations	No.
Systems Expansions	System expansion for by-products and energy replacing other products and other energy. Agricultural stage: straw burned in furnace substituting electricity from the grid (DK mix) and heat from co-generation (66% natural gas, 30% oil, 4% other) based on a Swiss co-gen plant. Processing stage: rapeseed meal substituting soybean meal from Brazil; biogas from residual rapeseed from screening process of incoming rapeseed substituting electricity from the grid (DK mix) and heat from co-generation (66% natural gas, 30% oil, 4% other) based on a Swiss co-gen plant. HVO production: biogasoline substituting naphtha; fuel gas substituting natural gas.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	Literature studies
Literature Reference	- Data for agriculture and rapeseed oil processing (reference 1). - Data for hydrotreatment at Neste oil (reference 2 & 3). (1) Schmidt, J.H. (2007). Life cycle assessment of rapeseed oil and palm oil. Ph.D. thesis, Part 3: Life cycle inventory of rapeseed oil and palm oil. (2) Institute for Energy and Environmental Reseach Heidelberg GmbH - IFEU (2006). An Assessment of Energy and Greenhouse Gases of NExBTL. (3) Arvidsson, R. & Persson, S. (2008). Life Cycle Assessment of NExBTL from Rape, Oil Palm and Jatropha. Master's Thesis in Chemical Environmental Science. (4) Mikkonen, S. et al. (2012). HVO, Hydrotreated Vegetable Oil - A Premium Renewable Biofuel for Diesel Engines. Neste Oil Corporation, p. 15. (5) Neste oil: NExBTL renewable diesel, Product information, page 15.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Resource	Crude oil	7.47382859477276E-03			kg	Ground	
Notes: A negative net total is due to different credit systems in the system expansion model. Of the credits for hardcoal as much as 75 % is due to replaced electricity in the rapeseed agricultural stage (electricity produced from combustion of straw by-product)	Input	Resource	Hard coal	-8.08471294906198E-05			kg	Ground	
	Input	Resource	Lignite	1.51562405772125E-03			kg	Ground	
	Input	Resource	Natural gas	3.32442801258314E-03			kg	Ground	
	Input	Resource	Uranium	1.10602711897682E-07			kg	Ground	
	Output	Emission	Ammonia	1.9441986972967E-04			kg	Air	
	Output	Emission	Ammonium / ammonia	2.84731302471634E-06			kg	Water	
	Output	Emission	Biological oxygen demand	6.26971942285403E-05			kg	Water	
	Output	Emission	Carbon dioxide (biogenic)	1.09463675308963E-02			kg	Air	
	Output	Emission	Carbon dioxide (fossil)	2.96188631911848E-02			kg	Air	
	Output	Emission	Carbon dioxide, land transformation	-0.023663389599738			kg	Air	
	Output	Emission	Carbon monoxide (biogenic)	2.73147690098474E-06			kg	Air	
	Output	Emission	Chemical oxygen demand	7.80863757004235E-05			kg	Water	
	Output	Emission	Hydrocarbons (unspecified)	6.70339493051345E-06			kg	Air	
	Output	Emission	Hydrogen sulfide	1.12721073795654E-07			kg	Air	

	Output	Emission	Methane (biogenic)	-2.57200730467303E-06			kg	Air	
	Output	Emission	Methane (fossil)	3.20314474411754E-05			kg	Air	
	Output	Emission	Nitrate	1.07753455383351E-09			kg	Air	
	Output	Emission	Nitrate	2.56802357154525E-03			kg	Water	
	Output	Emission	Nitrogen monoxide	6.16643092880716E-05			kg	Air	
	Output	Emission	Nitrogen oxides	1.88828689461934E-04			kg	Air	
	Output	Emission	Nitrous oxide	1.3762046599298E-04			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	-1.85345841537135E-04			kg	Air	
	Output	Emission	Particles (> PM10)	1.48437866906452E-05			kg	Air	
	Output	Emission	Particles (PM0.2 - PM2.5)	5.58153923248561E-07			kg	Air	
	Output	Emission	Particles (PM2.5)	-7.58026369531408E-05			kg	Air	
	Output	Emission	Phosphate	2.35631659282344E-05			kg	Water	
	Output	Emission	Phosphorus	3.15836194381823E-08			kg	Air	
	Output	Emission	Phosphorus	-4.87273820678863E-06			kg	Water	
	Output	Emission	Sulfur dioxide	1.11010401005601E-04			kg	Air	
	Output	Emission	Total dissolved organic bounded carbon	1.88398640605594E-05			kg	Water	
	Output	Emission	Total organic bounded carbon	1.9197684968273E-05			kg	Water	
	Output	Product	HVO - Rapeseed oil	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Felipe Oliveria, IVL.
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	There are two well to tank data sets for HVO published within this f3 project; HVO from palm oil and rapeseed oil.

SPINE LCI dataset: Iceland, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31

Copyright	IEA
Availability	Public

Technical System

Name	Iceland, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Iceland
Sector	Energyware
Owner	Iceland
Technical system description	The generation of electricity with different power generating systems in Iceland during the year 1998.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	0			GWh	Technosphere	

Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	5			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	5621			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	655			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	6281			GWh	Technosphere	

About Inventory	
Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998

	Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Incineration of aluminium

Administrative	
Finished	Y
Date Completed	1990
Copyright	
Availability	

Technical System	
Name	Incineration of aluminium
Functional Unit	1 kg
Functional Unit Explanation	The incineration of 1 kg aluminium.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	Incineration of aluminium at a thermal energy plant, which uses waste as fuel.

System Boundaries	
Nature Boundary	The emissions to air are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	The energy extracted and the material used are accounted for.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1990
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The data are taken from RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Literature Reference	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Aluminium	1			kg	Technosphere	Sweden
	Output	Emission	Ash	1899			g	Air	Sweden
Method: Since it is difficult to say anything about the radical formation of the various materials, NOx formation has been assumed to be proportional to their heat content. This involves the assumption that the thermal NOx formation plays a more important role. Se notes. Notes: The emissions of NOx are more dependent on the technical aspects of inceneration than the composition of the material. NOx are invariably formed during inceneration. It may be formed from the nitrogen content of the fuel of the nitrogen in the combustion air. In the incineration of waste which has low contents of nitrogen, the formation of NOx mostly comes from the nitrogen in the air. The NOx is formed from the air in two different ways. 1. Immidiate NOx formation from the nitrogen in the air at the front of the frame due to hydrocarbon radicals from fuel. The amount is fairly small during lage-scale incineration and in most cases can be disregarded. 2. Thermal NOx formation starts at 900 degrees Celsius, but only becomes significant at 1200 degrees Celsius. The higher the temperature and the longer the flue gases remain in the high-temperature zone, the greater the NOx emissions. Refering to McKinsey & Company, Inc. ''Integrated substance chain management'' (and appendix); Association of the Dutch Chemical Industry (VNCI); Leidschendamm, The Netherlands; 1991.	Output	Emission	NOx	4.90			g	Air	
Method: The material-specific particulate emission depend on the ash content of each material. The residues consist of 10% fly ash, while 90% is bottom slag. The separation rate used for particulate is 99,6%. The figures have been desided through personal communication with Carl-Arne Pedersen and Christer Lundgren, Sävenäs waste heat plant, GRAAB, Göteborg	Output	Emission	Particulates	0.76			g	Air	
	Output	Product	Thermal energy	30.6			MJ	Technosphere	

About Inventory

Publication	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about waste treatment.
Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	

Applicability	The data can be used, when one wants to estimate the emissions to air and the energy extracted, when 1 kg aluminium is incinerated at a thermal energy plant, that uses waste as fuel. The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system.
About Data	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occur. The lack of information is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclusions about these emissions.
Notes	

SPINE LCI dataset: Incineration of biological household waste. ESA-DBP

Administrative	
Finished	Y
Date Completed	2006-2007
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Incineration of biological household waste. ESA-DBP
Functional Unit	1 ton of biological household waste
Functional Unit Explanation	The functional unit is 1 ton of dry substance biological household waste.
Process Type	Gate to grave
Site	RenovaSävenäs, Sweden
Sector	Waste treatment
Owner	RenovaSävenäs, Sweden
Technical system description	The household waste is combusted in an oven, which produces steam that runs a turbine with a generator and a pressure condenser for production of electricity and district heating. The total combustion capacity is 59 tons of waste per hour. Moisture content in the waste is in average 32 %. The smoke and gases that are produced by the combustion are carried off via an exhaust steamboiler to a treatment plant including several steps. Translated excerpts from the report (see 'Publication'): ''The alternative to digestion of the waste is incineration in the power plant in Gothenburg. The tranpsort to the incineration plant ie executed with large lorries á 30 tons waste per each. At the plant heat and electricity are extracted from the incinerated waste. In this alternative case artificial fertilizer replaces the bio fertilizer and petrol and diesel replaces the vehicle gas.'' Processes included in the incineration system: - Incineration plant - Waste transport, one-way - Petrol in light vehicles - Diesel in heavy vehicles - Production of artificial fertilizer Processes not included in the incineration system: - Electricity use at the plant - Ashes and slag

	- Transport of artificila fertilizer - Use of chemicals This process is included in the system described in: Ljungkvist H, 2008, Miljö- och samhällsekonomisk analys av behandling av biologiskt avfall. Environmental Systems Analysis report 2008:1, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2008--1.pdf Other processes in the CPM Database also included in the above publication: 'Anaerobic digestion of biological household waste. ESA-DBP'

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	The documentor makes a qualified guess that the data was produced in the years 2006-2007, based on information in the report.
Geographical Boundary	The incineration plant is located in Sävenäs, Gothenburg, Sweden Translated excerpts from the report (see 'Publication'): ''Only emissions form one-way transport are allocated to the incineration alternative, since the cars often have other commissions on the way back. One-way distance is 110 kilometers.''
Other Boundaries	Translated excerpts from the report (see 'Publication'): ''The alternative to digestion of the waste is incineration in the power plant in Gothenburg. The tranpsort to the incineration plant ie executed with large lorries á 30 tons waste per each. At the plant heat and electricity are extracted from the incinerated waste. In this alternative case artificial fertilizer replaces the bio fertilizer and petrol and diesel replaces the vehicle gas.'' Processes included in the incineration system: - Incineration plant - Waste tranport, one-way - Petrol in light vehicles - Diesel in heavy vehicles - Production of artificial fertilizer Processes not included in the incineration system: - Electricity use at the plant - Ashes and slag - Transport of artificila fertilizer - Use of chemicals
Allocations	Not applicable.
Systems Expansions	For comparison with the anaerobic digestion alternative emissions from produciton of artificial fertilizer and production of petrol and diesel are included.

Flow Data

General Activity QMetaData

Date Conceived	2006-2007
Data Type	Derived, mixed
Represents	See 'Function'.
Method	Not applicable.
Literature Reference	Ljungkvist H, 2008, Miljö- och samhällsekonomisk analys av behandling av biologiskt avfall. Environmental Systems Analysis report 2008:1, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2008--1.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Input Product	Biological household waste	1000			kg	Technosphere	Sweden
	Output	Emission	CH4	0.05			kg	Air	Sweden
	Output	Emission	CO	5.05			kg	Air	Sweden
Notes: From fossil fuels.	Output	Emission	CO2	346.11			kg	Air	Sweden

	Output	Emission	HC	0.94			kg	Air	Sweden
	Output	Emission	HCl	0.99			kg	Air	Sweden
	Output	Emission	Hg	120			mg	Air	Sweden
	Output	Emission	N2O	0.06			kg	Air	Sweden
	Output	Emission	NMVOC	0.05			kg	Air	Sweden
	Output	Emission	NOx	24.28			kg	Air	Sweden
	Output	Emission	PAH	31			mg	Air	
	Output	Emission	Particles	3.64			kg	Air	Sweden
	Output	Emission	SOx	1.00			kg	Air	Sweden
	Output	Product	District heating	5500			kWh	Technosphere	Sweden
	Output	Product	Electricity	2500			kWh	Technosphere	Sweden

About Inventory	
Publication	Ljungkvist H, 2008, Miljö- och samhällsekonomisk analys av behandling av biologiskt avfall. Environmental Systems Analysis report 2008:1, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2008--1.pdf
Intended User	LCA practitioners and employees at Ragn-Sells.
General Purpose	Master Thesis. Excerpt from the report (see 'Publication'): ''Biogas is a renewable fuel that can be extracted from anaerobic digestion of many different substrates, for example biological household waste. An alternative handling of the waste is to mix it with other wastes and incinerate it in a combined heat and power (CHP) plant. This study uses life cycle assessment to investigate which type of waste handling that is better from an environmental point of view, anaerobic digestion with biogas production or incineration. The results are based on a case study of a biogas production plant owned by the company Ragn-Sells in Vänersborg. The alternative is incineration at a CHP plant in Gothenburg.''
Detailed Purpose	These are the data for the combustion process.
Commissioner	Ragn-Sells - .
Practitioner	Ljungkvist, Hanna - .
Reviewer	Palme, Ulrika -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Translated excerpts from the report (see 'Publication'): ''The tranpsort to the incineration plant ie executed with large lorries á 30 tons waste per each.'' ''Emission data from fertilizer production is based on LCA data from Berglund and Börjesson (2003).'' NB: Whole reference can be found in the publication. ''For emissions from the incineration plant, used data is from tables in Baumann and Tillman (2004) for incineration of biological household waste. In reality this waste is mixed with other fractions before incineration.'' NB: Whole reference can be found in the publication. The power plant produces its own electricity. ____ ESA Database Project. Years: 2009-2011. Documentation completed for this data set: YYYY-MM-DD Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA. Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Incineration of corrugated board

Administrative	
Finished	Y
Date Completed	1990
Copyright	
Availability	Public

Technical System	
Name	Incineration of corrugated board
Functional Unit	1 kg
Functional Unit Explanation	The incineration of 1 kg corrugated board.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	Incineration of corrugated board at a thermal energy plant, which uses waste as fuel.

System Boundaries	
Nature Boundary	The emissions to air are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	The energy extracted and the material used are accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData	
Date Conceived	1990
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data are taken from RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Literature Reference	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Moisture content 15%	Input	Refined resource	Corrugated board	1			kg	Technosphere	Sweden
	Output	Emission	Ash	19.998			g	Air	Sweden
Method: Since it is difficult to say anything about the radical formation of the various materials, NOx formation has been assumed to be proportional to their heat content. This involves the assumption that the thermal NOx formation plays a more important role. Se notes. Notes: The emissions of NOx are more	Output	Emission	NOx	2.67			g	Air	

dependent on the technical aspects of inceneration than the composition of the material. NOx are invariably formed during inceneration. It may be formed from the nitrogen content of the fuel of the nitrogen in the combustion air. In the incineration of waste which has low contents of nitrogen, the formation of NOx mostly comes from the nitrogen in the air. The NOx is formed from the air in two different ways. 1. Immidiate NOx formation from the nitrogen in the air at the front of the frame due to hydrocarbon radicals from fuel. The amount is fairly small during lage-scale incineration and in most cases can be disregarded. 2. Thermal NOx formation starts at 900 degrees Celsius, but only becomes significant at 1200 degrees Celsius. The higher the temperature and the longer the flue gases remain in the high-temperature zone, the greater the NOx emissions. Refering to McKinsey & Company, Inc. ''Integrated substance chain management'' (and appendix); Association of the Dutch Chemical Industry (VNCI); Leidschendamm, The Netherlands; 1991.									
Method: The material-specific particulate emission depend on the ash content of each material. The residues consist of 10% fly ash, while 90% is bottom slag. The separation rate used for particulate is 99,6%. The figures have been desided through personal communication with Carl-Arne Pedersen and Christer Lundgren, Sävenäs waste heat plant, GRAAB, Göteborg	Output	Emission	Particulates	0.008			g	Air	
	Output	Product	Thermal energy	16.7			MJ	Technosphere	

About Inventory

Publication	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about waste treatment.
Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air and the energy extracted, when 1 kg corrugated board is incinerated at a thermal energy plant, that uses waste as fuel. The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system.
About Data	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Notes	

SPINE LCI dataset: Incineration of linoleum

Administrative	
Finished	Y
Date Completed	1990
Copyright	
Availability	Public

Technical System	
Name	Incineration of linoleum
Functional Unit	1 kg
Functional Unit Explanation	The incineration of 1 kg linolium.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	Incineration of linoleum at a thermal energy plant, which uses waste as fuel.

System Boundaries	
Nature Boundary	The emissions to air are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	The energy extracted and the material incinerated are accounted for.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1990
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data are taken from Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994
Literature Reference	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Linoleum	1			kg	Technosphere	Sweden
	Output	Emission	Ash	217			g	Air	Sweden
Method: Since it is difficult to say anything about the radical formation of the various materials, NOx formation has been assumed to be proportional to their heat content. This involves the assumption that the thermal NOx formation plays a more important role. Se notes. Notes: The emissions of NOx are more dependent on the technical aspects of inceneration than the composition of the material. NOx are invariably formed during inceneration. It may be formed from the nitrogen content of the fuel of the nitrogen in the combustion air. In the incineration of waste which has low contents of nitrogen, the formation of NOx mostly comes from the nitrogen in the air. The NOx is formed from the air in two different ways. 1. Immidiate NOx formation from the nitrogen in the air at the front of the frame due to hydrocarbon radicals from fuel. The amount is fairly small during lage-scale incineration and in most cases can be disregarded. 2. Thermal NOx formation starts at 900 degrees Celsius, but only becomes significant at 1200 degrees Celsius. The higher the temperature and the longer the flue gases remain in the high-temperature zone, the greater the NOx emissions. Refering to McKinsey & Company, Inc. ''Integrated substance chain management'' (and appendix); Association of the Dutch Chemical Industry (VNCI); Leidschendamm, The Netherlands; 1991.	Output	Emission	NOx	2			g	Air	
	Output	Product	Thermal energy	12.5			MJ	Technosphere	

About Inventory

Publication	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994 -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about floor-materials.
Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Jönsson Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden.
Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air and the energy extracted, when 1 kg linoleum is incinerated at a thermal energy plant, that uses waste as fuel. The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system.

About Data	
Notes	

SPINE LCI dataset: Incineration of paperboard for liquids

Administrative	
Finished	Y
Date Completed	1990
Copyright	
Availability	

Technical System	
Name	Incineration of paperboard for liquids
Functional Unit	1 kg
Functional Unit Explanation	The incineration of 1 kg paperboard for liquids.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	Incineration of paperboard for liquids at a thermal energy plant, which uses waste as fuel.

System Boundaries	
Nature Boundary	The emissions to air are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	The energy extracted and the material incinerated are accounted for.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1990
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data are taken from RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Literature Reference	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***

Notes: Moisture content 12%	Input	Refined resource	Paperboard for liquids	1			kg	Technosphere	Sweden
	Output	Emission	Ash	74.798			g	Air	Sweden
Method: The material-specific emission factors for CO2 have been calculated on the basis of elementary analysis.	Output	Emission	CO2	696.22			g	Air	
Method: Since it is difficult to say anything about the radical formation of the various materials, NOx formation has been assumed to be proportional to their heat content. This involves the assumption that the thermal NOx formation plays a more important role. Se notes. Notes: The emissions of NOx are more dependent on the technical aspects of inceneration than the composition of the material. NOx are invariably formed during inceneration. It may be formed from the nitrogen content of the fuel of the nitrogen in the combustion air. In the incineration of waste which has low contents of nitrogen, the formation of NOx mostly comes from the nitrogen in the air. The NOx is formed from the air in two different ways. 1. Immidiate NOx formation from the nitrogen in the air at the front of the frame due to hydrocarbon radicals from fuel. The amount is fairly small during lage-scale incineration and in most cases can be disregarded. 2. Thermal NOx formation starts at 900 degrees Celsius, but only becomes significant at 1200 degrees Celsius. The higher the temperature and the longer the flue gases remain in the high-temperature zone, the greater the NOx emissions. Refering to McKinsey & Company, Inc. ''Integrated substance chain management'' (and appendix); Association of the Dutch Chemical Industry (VNCI); Leidschendamm, The Netherlands; 1991.	Output	Emission	NOx	3.10			g	Air	
Method: The material-specific particulate emission depend on the ash content of each material. The residues consist of 10% fly ash, while 90% is bottom slag. The separation rate used for particulate is 99,6%. The figures have been desided through personal communication with Carl-Arne Pedersen and Christer Lundgren, Sävenäs waste heat plant, GRAAB, Göteborg	Output	Emission	Particulates	0.02993			g	Air	
	Output	Product	Thermal energy	19.38			MJ	Technosphere	

About Inventory

Publication	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about waste treatment.
Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air and the energy extracted, when 1 kg wood is incinerated at a thermal energy plant, that uses waste as fuel. The data are valid for Swedish conditions, but can be used as an approximation to other

	countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system.
About Data	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.
Notes	

SPINE LCI dataset: Incineration of polyethylene

Administrative	
Finished	Y
Date Completed	1990
Copyright	
Availability	

Technical System	
Name	Incineration of polyethylene
Functional Unit	1 kg
Functional Unit Explanation	The incineration of 1 kg polyethylene.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	Incineration of polyethylene at a thermal energy plant, which uses waste as fuel.

System Boundaries	
Nature Boundary	The emissions to air are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	The energy extracted and the material incinerated are accounted for.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1990
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data are taken from RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.

Literature Reference	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Polyethylene	1			kg	Technosphere	Sweden
Method: The material-specific emission factors for CO2 have been calculated on the basis of elementary analysis.	Output	Emission	CO2	3138			g	Air	
Method: Since it is difficult to say anything about the radical formation of the various materials, NOx formation has been assumed to be proportional to their heat content. This involves the assumption that the thermal NOx formation plays a more important role. Se notes. Notes: The emissions of NOx are more dependent on the technical aspects of inceneration than the composition of the material. NOx are invariably formed during inceneration. It may be formed from the nitrogen content of the fuel of the nitrogen in the combustion air. In the incineration of waste which has low contents of nitrogen, the formation of NOx mostly comes from the nitrogen in the air. The NOx is formed from the air in two different ways. 1. Immidiate NOx formation from the nitrogen in the air at the front of the frame due to hydrocarbon radicals from fuel. The amount is fairly small during lage-scale incineration and in most cases can be disregarded. 2. Thermal NOx formation starts at 900 degrees Celsius, but only becomes significant at 1200 degrees Celsius. The higher the temperature and the longer the flue gases remain in the high-temperature zone, the greater the NOx emissions. Refering to McKinsey & Company, Inc. ''Integrated substance chain management'' (and appendix); Association of the Dutch Chemical Industry (VNCI); Leidschendamm, The Netherlands; 1991.	Output	Emission	NOx	6.88			g	Air	
	Output	Product	Thermal energy	43			MJ	Technosphere	

About Inventory

Publication	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about waste treatment.
Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	

Applicability	The data can be used, when one wants to estimate the emissions to air and the energy extracted, when 1 kg aluminium is incinerated at a thermal energy plant, that uses waste as fuel. The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system.
About Data	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.
Notes	

SPINE LCI dataset: Incineration of polystyrene

Administrative	
Finished	Y
Date Completed	1990
Copyright	
Availability	Public

Technical System	
Name	Incineration of polystyrene
Functional Unit	1 kg
Functional Unit Explanation	The incineration of 1 kg polystyrene.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	Incineration of polystyrene at a thermal energy plant, which uses waste as fuel.

System Boundaries	
Nature Boundary	The emissions to air are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	The energy extracted and the material incinerated are accounted for.
Allocations	
Systems Expansions	

Flow Data
General Activity QMetaData

Date Conceived	1990
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data are taken from RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Literature Reference	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Polystyrene	1			kg	Technosphere	Sweden
Method: The material-specific emission factors for CO2 have been calculated on the basis of elementary analysis	Output	Emission	CO2	3380			g	Air	Sweden
Method: Since it is difficult to say anything about the radical formation of the various materials, NOx formation has been assumed to be proportional to their heat content. This involves the assumption that the thermal NOx formation plays a more important role. Se notes. Notes: The emissions of NOx are more dependent on the technical aspects of inceneration than the composition of the material. NOx are invariably formed during inceneration. It may be formed from the nitrogen content of the fuel of the nitrogen in the combustion air. In the incineration of waste which has low contents of nitrogen, the formation of NOx mostly comes from the nitrogen in the air. The NOx is formed from the air in two different ways. 1. Immidiate NOx formation from the nitrogen in the air at the front of the frame due to hydrocarbon radicals from fuel. The amount is fairly small during lage-scale incineration and in most cases can be disregarded. 2. Thermal NOx formation starts at 900 degrees Celsius, but only becomes significant at 1200 degrees Celsius. The higher the temperature and the longer the flue gases remain in the high-temperature zone, the greater the NOx emissions. Refering to McKinsey & Company, Inc. ''Integrated substance chain management'' (and appendix); Association of the Dutch Chemical Industry (VNCI); Leidschendamm, The Netherlands; 1991.	Output	Emission	NOx	6.40			g	Air	
	Output	Product	Thermal energy	40			MJ	Technosphere	

About Inventory

Publication	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about waste treatment.
Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.

Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air and the energy extracted, when 1 kg polystyrene is incinerated at a thermal energy plant, that uses waste as fuel. The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system.
About Data	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.
Notes	

SPINE LCI dataset: Incineration of PVC

Administrative	
Finished	Y
Date Completed	1990
Copyright	
Availability	

Technical System	
Name	Incineration of PVC
Functional Unit	1 kg
Functional Unit Explanation	The incineration of 1 kg PVC.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	Incineration of PVC at a thermal energy plant, which uses waste as fuel.

System Boundaries	
Nature Boundary	The emissions to air are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	The energy extracted and the material incinerated are accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1990
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data are taken from RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Literature Reference	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	PVC	1			kg	Technosphere	Sweden
	Output	Emission	Ash	554.4			g	Air	Sweden
Method: The material-specific emission factor for CO2 has been calculated on the basis of elementary analysis.	Output	Emission	CO2	1407			g	Air	Sweden
Method: The material-specific emission factor for HCl has been calculated on the basis of elementary analysis.	Output	Emission	HCl	29.2			g	Air	Sweden
Method: Since it is difficult to say anything about the radical formation of the various materials, NOx formation has been assumed to be proportional to their heat content. This involves the assumption that the thermal NOx formation plays a more important role. Se notes. Notes: The emissions of NOx are more dependent on the technical aspects of inceneration than the composition of the material. NOx are invariably formed during inceneration. It may be formed from the nitrogen content of the fuel of the nitrogen in the combustion air. In the incineration of waste which has low contents of nitrogen, the formation of NOx mostly comes from the nitrogen in the air. The NOx is formed from the air in two different ways. 1. Immidiate NOx formation from the nitrogen in the air at the front of the frame due to hydrocarbon radicals from fuel. The amount is fairly small during lage-scale incineration and in most cases can be disregarded. 2. Thermal NOx formation starts at 900 degrees Celsius, but only becomes significant at 1200 degrees Celsius. The higher the temperature and the longer the flue gases remain in the high-temperature zone, the greater the NOx emissions. Refering to McKinsey & Company, Inc. ''Integrated substance chain management'' (and appendix); Association of the Dutch Chemical Industry (VNCI); Leidschendamm, The Netherlands; 1991.	Output	Emission	NOx	2.88			g	Air	
	Output	Product	Thermal energy	18			MJ	Technosphere	

About Inventory

Publication	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about waste treatment.

Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air and the energy extracted, when 1 kg PVC is incinerated at a thermal energy plant, that uses waste as fuel. The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system.
About Data	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.
Notes	

SPINE LCI dataset: Incineration of starch

Administrative	
Finished	Y
Date Completed	1990
Copyright	
Availability	

Technical System	
Name	Incineration of starch
Functional Unit	1 kg
Functional Unit Explanation	The incineration of 1 kg starch.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	Incineration of starch at a thermal energy plant, which uses waste as fuel.

System Boundaries	
Nature Boundary	The emissions to air are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	The energy extracted and the material incinerated are accounted for.
Allocations	

Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1990
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data are taken from RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Literature Reference	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Starch	1			kg	Technosphere	Sweden
Method: Since it is difficult to say anything about the radical formation of the various materials, NOx formation has been assumed to be proportional to their heat content. This involves the assumption that the thermal NOx formation plays a more important role. Se notes. Notes: The emissions of NOx are more dependent on the technical aspects of inceneration than the composition of the material. NOx are invariably formed during inceneration. It may be formed from the nitrogen content of the fuel of the nitrogen in the combustion air. In the incineration of waste which has low contents of nitrogen, the formation of NOx mostly comes from the nitrogen in the air. The NOx is formed from the air in two different ways. 1. Immidiate NOx formation from the nitrogen in the air at the front of the frame due to hydrocarbon radicals from fuel. The amount is fairly small during lage-scale incineration and in most cases can be disregarded. 2. Thermal NOx formation starts at 900 degrees Celsius, but only becomes significant at 1200 degrees Celsius. The higher the temperature and the longer the flue gases remain in the high-temperature zone, the greater the NOx emissions. Refering to McKinsey & Company, Inc. ''Integrated substance chain management'' (and appendix); Association of the Dutch Chemical Industry (VNCI); Leidschendamm, The Netherlands; 1991.	Output	Emission	NOx	2.67			g	Air	
	Output	Product	Thermal energy	16.7			MJ	Technosphere	

About Inventory

Publication	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about waste treatment.
Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.

Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air and the energy extracted, when 1 kg starch is incinerated at a thermal energy plant, that uses waste as fuel. The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system.
About Data	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.
Notes	

SPINE LCI dataset: Incineration of wood

Administrative	
Finished	Y
Date Completed	1990
Copyright	
Availability	

Technical System	
Name	Incineration of wood
Functional Unit	1 kg
Functional Unit Explanation	The incineration of 1 kg wood.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	Incineration of wood at a thermal energy plant, which uses waste as fuel.

System Boundaries	
Nature Boundary	The emissions to air are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	The energy extracted and the material incinerated are accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1990
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data are taken from RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Literature Reference	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Moisture content 12%	Input	Refined resource	Wood	1			kg	Technosphere	Sweden
	Output	Emission	Ash	19.998			g	Air	Sweden
Method: Since it is difficult to say anything about the radical formation of the various materials, NOx formation has been assumed to be proportional to their heat content. This involves the assumption that the thermal NOx formation plays a more important role. Se notes. Notes: The emissions of NOx are more dependent on the technical aspects of inceneration than the composition of the material. NOx are invariably formed during inceneration. It may be formed from the nitrogen content of the fuel of the nitrogen in the combustion air. In the incineration of waste which has low contents of nitrogen, the formation of NOx mostly comes from the nitrogen in the air. The NOx is formed from the air in two different ways. 1. Immidiate NOx formation from the nitrogen in the air at the front of the frame due to hydrocarbon radicals from fuel. The amount is fairly small during lage-scale incineration and in most cases can be disregarded. 2. Thermal NOx formation starts at 900 degrees Celsius, but only becomes significant at 1200 degrees Celsius. The higher the temperature and the longer the flue gases remain in the high-temperature zone, the greater the NOx emissions. Refering to McKinsey & Company, Inc. ''Integrated substance chain management'' (and appendix); Association of the Dutch Chemical Industry (VNCI); Leidschendamm, The Netherlands; 1991.	Output	Emission	NOx	2.72			g	Air	
Method: The material-specific particulate emission depend on the ash content of each material. The residues consist of 10% fly ash, while 90% is bottom slag. The separation rate used for particulate is 99,6%. The figures have been desided through personal communication with Carl-Arne Pedersen and Christer Lundgren, Sävenäs waste heat plant, GRAAB, Göteborg	Output	Emission	Particulates	0.008			g	Air	
	Output	Product	Thermal energy	17			MJ	Technosphere	

About Inventory

Publication	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990. --- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset),

	Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about waste treatment.
Detailed Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data can be used, when one wants to estimate the emissions to air and the energy extracted, when 1 kg wood is incinerated at a thermal energy plant, that uses waste as fuel. The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. It is difficult to use the data in a correct way, because so little information is given about the system.
About Data	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.
Notes	

SPINE LCI dataset: Inductor assembly

Administrative	
Finished	Y
Date Completed	2000-03-13
Copyright	Ericsson
Availability	Official

Technical System	
Name	Inductor assembly
Functional Unit	One gram inductor intended for surface mounting
Functional Unit Explanation	The motivation for choosing this functional unit is: · Suitable unit to work with in an LCA of a private branch exchanges (a complicated telecom product) · Important component of the MD110 product system and many other electronic products. DESIGN These facts are based on Ericsson technical specification of the component. Ericsson product number: REG 707 0119/3 Ericsson description: Miniature chip choke Chokes are examples of components with the same electrical function as inductors and transformers. GENERAL Miniature chip choke intended for automatic mounting and all soldering methods. MECHANICAL DATA

	Design: The chip choke is flame retardant encapsulated with high-temperature resistant copper winding and a cube-shaped core made of ferrite. Terminals: Design 1, Silver plated solder terminals Design 2, Terminals with tin plated brass. Dimensions: Height: 4.5 mm, Length: 3.2 mm, Width: 3.2 mm Weight: app. 0,12 g
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of an inductor. The activity is based on information acquired from one manufacturer. The description of the process is assumed to be general for this type of manufacture. The following process steps are included; 1. Core mounting 2. Epoxy-curing 3 Winding 4. Welding 5. Molding 6. Marking 7. Bending 8. Testing 9. Final control 10. Taping Details given: 1. Core mounting: Cores inserted into leadframe and fixed by adhesive (epoxy resin) emission negligible 3. Winding: 3 % of magnet wire recycled 4. Welding: Winding ends connected to the leads by ultrasonic welding 5. Molding: Abundant PPS is reused , scrapped PPS thermally decomposed 7. Bending: Abundant leadframe ist recycled 8. Testing: 100 %; scrap <1 % Additional information: Below is some additional information supplied by the component manufacturer. Our description of the component is a FR choke of type wound SMT choke. Chokes are similar to inductors. The annual production (97/98) was 25,000,000. In the factory also capacitors, other inductors and filters are produced. The general description is: Production of passive components with no environmental problems. Planned changes in production rate is that a second line with higher output for the component is in discussion.

System Boundaries

Nature Boundary	The emissions to air have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impact has been studied. Emissions to water and soil are excluded due to lack of data.
Time Boundary	1998 The answer from the manufacturer arrived in 1998 and they measured in 1998. The process technology used is most certainly the best available as the factory is located in western Germany and the company is well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturer is located in Germany.
Other Boundaries	Delimitation's to the system is the final step in the making of the inductor. The production of the subparts (e.g. Fe3O4, Copper magnet, CuSn6 and PPS) of the inductor is not included in this model. The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability.

Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory. The electricity consumption per component is well ascertained by the manufacturer.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data that is presented is calculated based on information from one component manufacturer. The information from the manufacturer was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: -The amount of each flow per functional unit is calculated for the component manufacturer In the information supplied by the manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+.+.ACn Step 2: The sum AC11+.+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow.
Literature Reference	RVF: ''Svensk avfallshantering 1990'', Malmö, November 1990.
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 6 mg/166.6 mg = 0.036 g Ag/g (stated as Silver in original answer)	Input	Refined resource	Ag	0.036			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Represents: The copper is used as magnet wire. Method: CM: 40 mg/166.6 mg = 0.24 g Cu/g (stated as copper in original answer) Notes: 3 % by mass of the Cu waste is recycled.	Input	Refined resource	Cu	0.24			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 12 mg/166.6 mg = 0.072 g Cu alloy/g (stated as Metal sheet of CuSn6 in original answer)	Input	Refined resource	Cu alloy	0.072			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Inductor (REG 707 0119/3) manufacturer states an electricty consumption of 29 kJ for one inductor which weighs 0,1666 grams. Hence, 29/(3,6*0,1666) =48,35 Wh / g inductor 50 % of the connected load of the used machinery,times the running time of the machinery per year, divided by the produced number of inductors per year. Connected load: about 70 kW; running time: 5800 hours/year; produced inductors per year: 25 million.	Input	Refined resource	Electricity	48			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 0.6 mg/166.6 mg = 0.0036 g Epoxy resin, liquid/g (stated as Epoxy resin in original answer)	Input	Refined resource	Epoxy	0.0036			g	Technosphere	

Date concieved: 1998 Data type: Derived, unspecified Method: CM: 45 mg/166.6 mg = 0.27 g Fe3O4/g (stated as ferrite in original answer)	Input	Refined resource	Fe3O4	0.27			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 350 mg/166.6 mg = 2.1 g PPS/g (stated as Polyphenyleneoxide in original answer)	Input	Refined resource	Polyphenyl oxide	2.1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 8 mg/166.6 mg = 0.048 g Sn/g (stated as Tin in original answer)	Input	Refined resource	Sn	0.048			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 3 mg/166.6 mg = 0.018 g Solder/g (stated as Solder in original answer)	Input	Refined resource	Solder	0.018			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Inductor (REG 707 0119/3) manufacturer states an emission of 0,07 mg SO2/COS for one inductor which weighs 0,1666 grams. I assume a 0,035 mg emission of SO2 and a 0,035 mg emission of COS. Hence, 0,035e-3/0,1666 = 2,1e-4 g COS g / g inductor COS is Carbonyl Sulfide	Output	Emission	Carbonyl sulfide	0.00021			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Inductor (REG 707 0119/3) manufacturer states an emission of 0,82 mg for one inductor which weighs 0,1666 grams. Hence, 0,82e-3/0,1666 = 4,92e-3 g CO2 / g inductor	Output	Emission	CO2	0.0049			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Inductor (REG 707 0119/3) manufacturer states an emission of 0,006 mg for one inductor which weighs 0,1666 grams. Hence, 0,006e-3/0,1666 =3,6e-5 g g / g inductor	Output	Emission	Hardener	0.000036			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Inductor (REG 707 0119/3) manufacturer states an emission of 0,07 mg SO2/COS for one inductor which weighs 0,1666 grams. I assume a 0,035 mg emission of SO2 and a 0,035 mg emission of COS. Hence, 0,035e-3/0,1666 = 2,1e-4 g SO2 g / g inductor	Output	Emission	SO2	0.00021			g	Air	
Date concieved: 1999 Data type: Derived, unspecified Method: Inductors = Life Cycle Inventory Model for production of one gram of inductors and transformers (applicable at least for telecommunication equipment)	Output	Product	Inductors	1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 3 mg/166.6 mg = 0.018 g Ag/g (stated as Silver in original answer) Notes: 100 % by mass of the silver waste is recycled.	Output	Residue	Ag	0.018			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 280 mg/166.6 mg = 1.68 g PPS/g (stated as Polyphenyleneoxide in original answer) Notes: 100 % by mass of the PPS waste is recycled.	Output	Residue	Polyphenyl sulphide	1.7			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 4 mg/166.6 mg = 0.024 g Sn/g (stated as Tin in original answer) Notes: 100 % by mass of the tin waste is recycled.	Output	Residue	Sn	0.024			g	Technosphere	

About Inventory

	Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
	Intended User	The intended use for this LCI
	General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
	Detailed Purpose	Map an inductor assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of inductors and resembling components in our telecom products. The usage for this set of data is life cycle assessments where inductors intended for surface mounting are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly

	12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to inductors intended for hole mounting in electronic equipment if you know how much the inductors weigh. The model is also intended to be representative for transformers in electronic equipment. -- Transports. -- Here follows a more detailed description of transports of materials and components to the respective manufacturer factories. These transports are not included in the model. CM1 = Component manufacturer one The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport. -- Truck transportation: -- Weight of component: 0.166 g Fe3O4 with weight 0.045 g is transported 1300 km by truck, i.e. 0.045 * 1300 km, Copper magnet 0.04 * 1500, PPS 0.35 * 2000, (CuSn6) 0.012 * 2700 Solder 0.003 * 1700 The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 856.9 gkm/0.166 g = 5162 gkm/g -- Boat transportation: -- Fe3O4 with weight 0.045 g is transported 20,000 km by boat, i.e. 0.045 * 20,000 km, Copper magnet 0.04 * 500, PPS 0.35 * 500, (CuSn6) 0.012 * 500 Solder 0.003 * 500 The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 1102.5 / 0.166 = 6641.57 gkm /g
About Data	The data is based on information from one German manufacturer. The information was gathered using a life cycle inventory questionnaire. The figures in the original answer from the manufacturer should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. The result is that approximately 78 % of the flows stated by the manufacturer were only calculated and 22 % were only estimated. The outline of the LCI data questionnaire that was used in the inventory follows below. No limitations or specifications were set for which substances they had to account -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the

	component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes. Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gathered it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (E.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount (mg). Amount In Product (mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production sites (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Integrated circuit capsule assembly

Administrative	
Finished	Y
Date Completed	2000-03-03
Copyright	Ericsson
Availability	Official

Technical System	
Name	Integrated circuit capsule assembly
Functional Unit	One gram of integrated circuit capsule.
Functional Unit Explanation	The motivation for choosing this functional unit is: · suitable unit to work with in an LCA of a private branch exchange (a complicated telecom product) · important component of the MD110 product system and many other electronic products. DESIGN

	The answers from component manufacturer one (CM1) and component manufacturer three (CM3) are for exactly the same type of component. Component manufacturer one (CM2) produces protype capsules of an other kind of IC. These facts are based on Ericsson technical specification of the component. Ericsson product number: RYT 304 0164/C Ericsson description of the integrated circuit capsule: Microcircuit, HCMOS, 8 bit shift register General technical specification The circuit consists of an eight bit parallel-out serial shift register. All outputs standard type. Representative type: 74HC164 Small out line package (SO) with 14 terminals and 4.90 mm nominal width. Dimensions: capsule size SOP14 Weight: about 0.135 grams Silicon chip area: 2.3 mm2 The size of the circuits varies depending on chip size, and number of terminals of the leadframe. Large importance has also the type of capsule. Important measures for the capsule type Small Outline Package (SOP) and Plastic Lead Chip Carrier (PLCC) are in this range: Total package height (mm): 4,19 - 5,08 (for PLCC) Terminal thickness (mm): 0,19-0,32 (for SOP) Total body lenght including terminals (mm): 9,77-30,36 (for PLCC) Total package width including terminals (mm): 5,8-10,65 (for SOP) Total number of terminals (mm): 20-84 (for PLCC)
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final encapsulation assembly of an integrated circuit capsule. The activity is an average based on information acquired from three manufacturers. The description of the process is supplied by manufacturer one, but is assumed to be general for this type of manufacture. The following process steps are included; 1. Wafer Mounting 2. Wafer Sawing 3. Die Attach (die bonding onto a leadframe) 4. Snap Cure 5. Wire Bonding 6. Molding 7. Post Mold Cure 8. Deflashing 9. Plating (Solder- or tin) 10. Cropping&Laser Marking 11. Testing 12. Tape & Reel 13. Labelling&Packing No detailed description was given by manufacturer one, two or three. The transports between the wafer fab and the final capsule production are not included.

System Boundaries	
Nature Boundary	The emissions to air and water have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impacts have been studied. Included component manufacturers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used.

Time Boundary	1997-1998 The information from CM1 and CM2 is from 1997 and the answer from the manufacturer three (CM3) arrived in 1998 and they measured in 1998. The process technology used is most certainly the best available as the factories are located in the Netherlands, Sweden and Malaysia and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturers included in the average are located in the Netherlands, Sweden and Malaysia.
Other Boundaries	Delimitations to the system is the final encapsulation assembly of an integrated circuit (IC). The production of the sub-components (e.g. lead frame, Au-wire) needed to produce the final IC is not included. The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data that are presented are calculated as a average based on information from three component manufacturers. The information from the manufacturers was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers In the information supplied by the manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+..+.ACn Step 2: The sum AC11+..+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to three answers was made.
Literature Reference	Literaturreferences or contact persons aided the data compilation:. Jens Malmodin, Ericsson Radio Systems
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 2.8 mg/g This is not an average value and the figure is based only on one answer. Notes: This is part of lead frame.	Input	Refined resource	Ag	0.0028			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 15,74 mg/g This is not an average value and the figure is based only on one answer. Notes: Antimony trioxide has CAS-number 1309-64-4	Input	Refined resource	Antimony trioxide	0.01574			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: (1,11+3,8)/2= 2,455 mg/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Au	0.002455			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 8,88 mg/g This is not an average value and the figure is based	Input	Refined resource	Br	0.00888			g	Technosphere	

only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 712 mg/g This is not an average value and the figure is based only on one answer. Notes: This is packaging material.	Input	Refined resource	Cardboard	0.712			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 1250 mg/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Copper	1.25			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Comp. man 1: 39,3 Wh / g capsule Comp. man 2: 0,54 Wh / g capsule Comp. man 3: (65/2) g capsule --> 32,5 Wh /g (39,3 + 0,54 + 32,5)/3 = 24,11 Wh/g capsule This is an average value based on three sources. Literature: 3 Comp man.	Input	Refined resource	Electricity	24.11			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: (1319+1830)/2= 1574,5 mg/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Epoxy	1.5745			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 493,5 mg/g This is not an average value and the figure is based only on one answer. Literature: Comp. man.	Input	Refined resource	N2	0.4935			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 69 mg/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Organics	0.0345			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 13,15 mg/g CM2: 88 mg/g (CM1+CM2)/2 = 50,575 mg/g This is an average value based on two sources.	Input	Refined resource	Polypropylene	0.050575			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: One m2 of Si wafer weighs 1.6 kg. The thickness of the wafer is 675e-6 m. This means 1 mm2 Si wafer weighs 0.0016 g 1 g Integrated circuit capsule would then correspond to an input of 625 mm2 Si wafer. This is not an average value and the figure is based only on one answer.	Input	Refined resource	Silicon wafer	625			mm2	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Represents: This flow refers to SiO2-particles which are part of the Epoxy plastic. Method: CM2: 1080 mg/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	SiO2	1.08			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 1,04 mg/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Sn	0.00104			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 192,75 mg/g CM3: 287 mg/g (CM1+ CM3)/2 = 239,875 mg/g This is an average value based on two sources.	Input	Refined resource	Sn/Pb plating	0.239875			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1916 mg/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Water	1.916			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1,54 mg/g capsule This is not an average value and the figure	Output	Emission	Cl, Si, B	0.00154			g	Water	

is based only on one answer. Literature: The component manufacturer									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 493,5 mg/g This is not an average value and the figure is based only on one answer. Literature: Comp. man.	Output	Emission	N2	0.4935			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 69 mg/g This is not an average value and the figure is based only on one answer. Literature: Comp. man.	Output	Emission	Organics	0.069			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,37 * 44,45 = 16,44 mg/g This is not an average value and the figure is based only on one answer. Literature: Comp. man.	Output	Emission	Pb	0.01644			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,63*44,45 = 28 mg/g This is not an average value and the figure is based only on one answer.	Output	Emission	Sn	0.028			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1916 mg/g This is not an average value and the figure is based only on one answer. Literature: One Comp. man.	Output	Emission	Water	1.916			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: Integrated circuit capsule = Life Cycle Inventory model for production of one gram of integrated circuit capsule (applicable to telecommunication equipment). (This model is based on two questionnaire answers and one broschure). The literature report describes the IC capslue assembly of prototype IC´s in a Swedish factory. The prototypes are not of the same type as the component manufacturer answers.	Output	Product	Integrated circuit capsule	1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.311 mg/g This is not an average value and the figure is based only on one answer.	Output	Residue	Al	0.000311			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 117,98 mg/g This is not an average value and the figure is based only on one answer.	Output	Residue	Cardboard	0.11798			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 1000 mg/g This is not an average value and the figure is based only on one answer.	Output	Residue	Copper	1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: (619+1253,2)/2= 936 mg/g This is not an average value and the figure is based only on one answer.	Output	Residue	Epoxy	0.936			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 13.15 mg/g This is not an average value and the figure is based only on one answer.	Output	Residue	Polypropylene	0.01315			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 129 mg/g CM3: 237,8 mg/g (CM1+ CM3)/2 = 183,4 mg/g This is an average value based on two sources.	Output	Residue	Sn/Pb plating	0.1834			g	Technosphere	

About Inventory

Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map an IC assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of microcircuits and resembling components in our telecom products. The usage for this set of data are life cycle assessments where microcircuits (integrated circuits) are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly

	12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to integrated circuits (i.e. IC´s) in electronic equipment if you know the total weight of the IC´s. The model is intended to be representative for microcircuits, oscillators, quartz crystal units and delay lines in electronic equipment. -- Transports-- Here follows a more detailed description of transports of materials and components to the respective manufacturer factories. These transports are not included in the model. CM1 = Component manufacturer one The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport. -- Truck transportation: -- Component manufacturer one (CM3): Weight of component: 0.119 g Silicon die with weight 0.0015 g is transported 10 km by road i.e. 0.0015 g*10 km, Lead frame 0.05 g*10 km, Wires 0.0025 g*350 km, Filled epoxy resin 0.062 g*350 km and Solder 0.006 g*250 km. The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 24.59 gkm/0.119 g = 206.63 gkm/g -- Airplane transportation: -- Silicon die with weight 0.0015 g is transported 10000 km by air i.e. 0.0015 g*10000 km This gives: 15 gkm/0.119 g = 126.05 gkm/g
About Data	The data is based on information from three manufacturers. The information was gathered using a life cycle inventory questionnaire (CM2 and CM3) and brochures (CM1). CM1 answered with a brochure when asked to fill in the questionnaire. All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model. Of the flows about little more than 85 % are not average values.The flows for Energy input of Electricity, Raw material inputs of PP and Sn/Pb plating and Waste output of Sn/Pb plating are average values. In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included. The figures in the original answer from the manufacturers all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. Only in one source (CM3) this information was given. The result is that approximately 35 % of the flows were only calculated and 65 % were only estimated. All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model.

	These flows were asked for and no limitations were set for which substances for which they had to account. Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes.´ Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gatherd it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Inventory of Volvo painting plant, TB4

Administrative	
Finished	Y
Date Completed	1996-10-21
Copyright	Chalmers University of Technology
Availability	Public.

Technical System	
Name	Inventory of Volvo painting plant, TB4
Functional Unit	''one produced coach at TB4 during 1994''

Functional Unit Explanation	A ''coach'' in this report is a coach from the Volvo 800- or 900-series. TB4 is one of Volvo Car Corporation's painting plant.
Process Type	Gate to gate
Site	Torslanda (Gothenburg)
Sector	Manufacturing
Owner	Torslanda (Gothenburg)
Technical system description	Technology descriptor: In this study, an inventory is performed on the painting process for Volvo Car Corporation's painting plant in Torslanda (Gothenburg), TB4. The following processes are done in TB4: filling, surface coatings, waste treatment, including touch-up of coatings and energy production. Detailed description follows below. Technical content and functionality: FILLING - Before the coach is coated, an undercoating of the chassis is done as a stone-protective device. Next, there is a finish grinding before the first coating is applied. Finish grinding is done to give the coach a smoother surface. The coach is washed and goes through a water-drying furnace. SURFACE COATING - Three layers of coating is applied on each coach: filler-, clear- and base coating. First the filler coating is applied as a protection layer. Thereafter the base coat is applied which contains the colour pigment. Finally a layer of clear coat is applied as a top protection layer. Filler coat, clear coat and base coat-solid are applied with a rotating decompositioner that rotates very fast and thereby finely disperse the paint. 80-85% of the colour sticks to the coach, the rest is removed with the water in the air cleaner, the so-called curtain water and goes out of the system as sludge. The base coat-metallic is applied in two layers. The first is applied with a rotating decompositioner. The second layer is applied with an air sprayer that uses compressed air to finely disperse the paint. Only 40-45% of the paint sticks to the coach. It gives a different nuance using two methods to apply the base coat-metallic, compared to using only the rotating decompositioner. Every layer of coating is preceded and followed by heating, cooling and coat control. The air-heating furnace is powered either by natural gas or by electricity. The hardening furnace that follows after the filler- and clear coating steps have a temperature of 130° C. The IR-dryer follows the base coating step. It consists of one IR-part (radiation dryer) and one pre-dryer; together they expel the water out of the coat-dispersion. In this step the temperature is about 80° C. After the washing, the coach is drained from water and then goes through a water-dryer (approximately 100-120° C). After every furnace there is a cooler, where the coach is cooled with air to room temperature. In between each coating the coach passes through a furnace, followed by a cooling step and finally a washing step. WASTE TREATMENT - In the coating boxes there is a lattice floor. The air in the boxes is sucked down the floor and goes through the water, which is under the lattice. The colour particles are dispersed in the water and give rise to sludge together with sludge chemicals. The air is cleaned further if the coating is containing solvents. The final cleaning of air, containing solvents, is done in the sand beds outside TB4, which gives CO_2 emissions. ENERGY PRODUCTION - TB4's energy central, TB5, is accounted for because its only purpose is to supply TB4 with energy. Energy sources in a descending order are electricity, natural gas, and district heating. Electricity: Except for the process itself and general use (for example general lighting), refrigerating machines and compressors are powered with electricity. District heating: The system includes a humidifier that uses district heating. Natural gas: TB5 has a natural gas driven hot water boiler.

System Boundaries

Nature Boundary	The selection of parameters was based on parameters from Volvo Car Corp.'s Environmental Report of 1994.
Time Boundary	The data was collected for 1994, unless other is mentioned, and one should consider some change in process steps etc. as times goes. The figures for energy application and emissions are from 1995, but have been weighted against quantities from 1994.
Geographical Boundary	Sweden
Other Boundaries	Downstream the boundary is set to that one painted coach, solvents to recycling, sludge, paint residues and discharge to air and water are outflows from TB4. Only sludge and paint residues are accounted for as waste (solvents are recycled). Excluded subsystems: The material- and energy application for the point improvement is assumed to be negligible in comparison with the total consumption and is not included. The heat requirement in TB4 is mainly covered with waste heat from Preem Refineries Corporation. Waste heat produced at Preem Refineries Corp. is outside the system

	boundaries of this study. Complementary combustion of natural gas is done in a common Volvo energy central, TD. (The discharge from the combustion of natural gas in TD is separately accounted for in the report 1996:9, Technical Environmental Planning, but has not been included in this activity). No transportations are accounted for in this documentation, only in Report 1996:9, Technical Environmental Planning. Excluded flows: Waste, such as packing material from smaller paint buckets etc., is not included since it's supposed to have a small environmental load compared to other flows. The production capital has no part in the study.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'.
Method	For a description on how the data was acquired, see specific QMetaData for each flow.
Literature Reference	Literaturreferences or contact persons aided the data compilation:. Jens Malmodin, Ericsson Radio Systems
Notes	No information is given about the emissions of CO and hydrocarbons, though emissions of these substances occour. The lack of informaiton is due to the fact that the evidence in the investigation of the emissions are too small to allow any general conclutions about these emissions.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1994 Data type: Unspecified Method: EMI, a database at Volvo Car Corp. Notes: Manufactured outside of Volvo.	Input	Refined resource	Base coat, metallic	4.35			kg	Technosphere	
Date concieved: 1994 Data type: Unspecified Method: EMI, a database at Volvo Car Corp. Notes: Manufactured outside of Volvo.	Input	Refined resource	Base coat, solid	2.08			kg	Technosphere	
Date concieved: 1994 Data type: Unspecified Method: EMI, a database at Volvo Car Corp. Notes: Manufactured outside of Volvo.	Input	Refined resource	Clear coat	2.68			kg	Technosphere	
Date concieved: 1994 Data type: Unspecified Method: Total energy, water and air consumption derives from Mihkel Laks, Volvo Car Corporation. Notes: Energy demand for TB4.	Input	Refined resource	District heating	972			MJ	Technosphere	
Date concieved: 1994 Data type: Unspecified Method: Total energy, water and air consumption derives from Mihkel Laks, Volvo Car Corporation Notes: Energy demand for TB4.	Input	Refined resource	Electricity	2196			MJ	Technosphere	
Date concieved: 1994 Data type: Unspecified Method: EMI, a database at Volvo Car Corp. Notes: Manufactured outside of Volvo.	Input	Refined resource	Filler coat	2.77			kg	Technosphere	
Date concieved: 1994 Data type: Unspecified Method: Total energy, water and air consumption derives from Mihkel Laks, Volvo Car Corporation Notes: Energy demand for TB4/TB5.	Input	Refined resource	Natural gas	1800			MJ	Technosphere	
Date concieved: 1995 Data type: Unspecified Method: The consumption of sealant was given by Dejan Nestarovic, Volvo Car Corporation. The sealant figures	Input	Refined resource	Sealants	4.15			kg	Technosphere	

are budgeted figures based on the consumption of 1995. Notes: Sealants = sealants based on PVC. Manufactured outside of Volvo.										
Date concieved: 1994 Data type: Unspecified Method: Information on sludge chemicals derives from Nils Malmbro, Volvo Car Corporation. Notes: Sludge chemicals = Maintenance chemicals for sprayboot systems.	Input	Refined resource	Sludge chemicals	1.7			kg	Technosphere		
Date concieved: 1994 Data type: Unspecified Method: EMI, a database at Volvo Car Corp. Notes: Solvents = 3,23 kg recycled solvents (Recycling outside of Volvo and then brought back to the system) & 0,92 kg produced solvents (Manufactured outside of Volvo).	Input	Refined resource	Solvents	4.15			kg	Technosphere		
Date concieved: 1994 Data type: Unspecified Method: EMI, a database at Volvo Car Corp. Notes: Manufactured outside of Volvo.	Input	Refined resource	Underbody paste	1.06			kg	Technosphere		
Date concieved: 1994 Data type: Unspecified Method: Data for the emissions was collected from the environmental report and therefore follows the data quality requirements by authorities. Notes: Emission from the energy demand for TB4/TB5.	Output	Emission	CO2	92			kg	Urban air		
Date concieved: 1994 Data type: Unspecified Method: Data for the emissions was collected from the environmental report and therefore follows the data quality requirements by authorities. Notes: Emission from the energy demand for TB4/TB5.	Output	Emission	Dust	0.00005		0.00005	kg	Urban air		
Date concieved: 1994 Data type: Calculated Method: Data for the emissions was collected from the environmental report and therefore follows the data quality requirements by authorities. Notes: Emission from the energy demand for TB4/TB5. Due to a breakdown in 1994 an estimated value based on the emissions for 1995 is used .	Output	Emission	HCFC-22	0.001			kg	Urban air		
Date concieved: 1994 Data type: Unspecified Method: Data for the emissions was collected from the environmental report and therefore follows the data quality requirements by authorities. Notes: Emission from the energy demand for TB4/TB5.	Output	Emission	NOx	0.2008			kg	Urban air		
Date concieved: 1994 Data type: Unspecified Method: Data for the emissions was collected from the environmental report and therefore follows the data quality requirements by authorities. Notes: Emission from the energy demand for TB4/TB5.	Output	Emission	Solvents	1.6			kg	Urban air		
Date concieved: 1994 Data type: Unspecified Method: Based on functional unit.	Output	Product	Painted coach	1			pce	Technosphere		
Date concieved: 1994 Data type: Unspecified Method: EMI, a database at Volvo Car Corp. Notes: Combustible waste.	Output	Residue	Paint residue	0.54			kg	Technosphere		
Date concieved: 1994 Data type: Unspecified Method: The amount of sludge was collected from Volvo Car Corporation's	Output	Residue	Paint sludge	4.54			kg	Technosphere		

Environmental Report of 1994. Notes: The sludge is combustible waste.									
Date concieved: 1994 Data type: Unspecified Method: EMI, a database at Volvo Car Corp. Notes: The unpure solvent is sent for recycling. 0,54 kg of that is paint residues wich is combustible waste. The rest (the pure solvent) is recycled back to the system, see ''Solvents''.	Output	Residue	Solvents, unpure	2.86			kg	Technosphere	

About Inventory

Publication	Elisabeth Andersson, Selection out of ''Inventering samt miljovardering av TB4, Volvo Personvagnars malerifabrik i Goteborg'', Report 1996:9, MSc thesis. Technical Environmental Planning, Chalmers University of Technology Göteborg, Sweden Data documented by: Dan Wahlström, Volvo Technological Development Corporation; Dept. of Environmental Science. Data reviewed by: Elisabeth Andersson and David Weiner, Volvo Technological Development Corporation; Dept. of Environmental Science. Documentation reviewed by: Ann-Christin Pålsson, CPM.
Intended User	LCA practitioners.
General Purpose	There has been some interest in performing a life cycle assessment of the painting process, especially since purification technique requires a great amount of energy.
Detailed Purpose	Perform an inventory of TB4. The Report (Report 1996:9, MSc thesis. Technical Environmental Planning, Chalmers University of Technology Göteborg, Sweden) which this data is based on, further follows in- and out-flows to/from TB4, but is not accounted for in this documentation.
Commissioner	Nevén, Carl-Otto - Volvo Car Corporation .
Practitioner	Andersson, Elisabeth - Volvo Technological Development Corp. Departement of Environmental Science .
Reviewer	Holmberg, Micaela - Volvo Technological Development Corp. Department of Environmental Science
Applicability	This documentation is based on a report (see Publication) which further follows in- and out-flows to/from TB4. All the data from the report has not been considered as relevant and is therefore not included in the documentation. The figures for the process changes as time goes, but it was considered a modern process in 1994 and the technique has not changed a lot. The environmental load for coating a coach is considered to be high, compared to other coating processes and therefore it could, in some cases, be used as a reference scenario.The figures could be used as a comparison with similiar coating processes. Only the production of some of the materials have been considered in the original report. Due to the great amount of chemical products that are used in TB4, only one or a couple of products of sealant, underbody pastes, fillers, base coats (both metallic and solid) and clear coats have been followed to the supplier (these flows are not followed and included in this data documentation, see Publication). The inventory data for the products that were used the most was collected and used in the valuation step as approximate values for similar products.
About Data	Data for sealants are approximated from the environmental report of 1995 to values for 1994. This is assumed not to have a great impact on the data quality, due to the large flows. Complementary information for the documentation of data, which were not available in the original report, has been retrieved from the author of the report, see Publication.
Notes	-

SPINE LCI dataset: Ireland, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Ireland, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Ireland
Sector	Energyware
Owner	Ireland
Technical system description	The generation of electricity with different power generating systems in Ireland during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	169			GWh	Technosphere	

Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	1694			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	4850			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	6430			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	6734			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	89			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	916			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded Notes: The value have been corrected after publishing. See Inventory Notes for a description.	Output	Product	Electricity	20882			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. --- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden ---
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998

	New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	-- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 22 October 2001: <<< Changes made by Ann-Christin Pålsson, CPM: The total electricity production have been corrected from 9 056 977 GWh to 20 881 GWh according to the original report. The error was identified and reported by Gunnar Mattson, ABB Corporate Research.

SPINE LCI dataset: Italy, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Italy, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Italy
Sector	Energyware
Owner	Italy
Technical system description	The generation of electricity with different power generating systems Italy during the year 1998. Italy includes San Marino anc the Vatican.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	107305			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	1228			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	231			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	27503			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	324			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	41220			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	4214			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	6			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	70883			GWh	Technosphere	
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	727			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	253641			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -

Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Japan, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Japan, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998

Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Japan
Sector	Energyware
Owner	Japan
Technical system description	The generation of electricity with different power generating systems in Japan during the year 1998. Japan includes Okinawa.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See "Represents" for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	12			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	169955			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	198035			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	21482			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	218343			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	332343			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	3531			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	6			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	92513			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	1036220			GWh	Technosphere	

About Inventory	
Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Jet plane, A 300-B4, 1200 km

Administrative	
Finished	Y
Date Completed	1999 - 12
Copyright	NTM
Availability	Public

Technical System	
Name	Jet plane, A 300-B4, 1200 km
Functional Unit	1 tonkm, 75 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 km calculated for 1200 km flight distance and an average utilisation level equivalent to 75 % of the aircrafts maximum payload capacity.
Process Type	Gate to gate
Site	Sweden
Sector	Air transport
Owner	Sweden
Technical system description	Operation of jet plane, type Airbus A 300-B4 with 2 engines Rolls Royce RB211-524, 1200 km, European flight, with 8 minutes of taxiing and landing run (3 min. in and 5 min. out). This is a larger plane, with a capacity of approximately 270 passengers in a passenger version. The plane presented here, however, is strictly a freight version which seats no passengers. Utilisation level is set to 75% for the medium quantity, 100% for ''min'' and 50% for ''max''. Fuel: Jet-A1. Takeoff Weight (TOW): 170 tons. Speed (cruise): 897 km/h. Maximum payload 45 000 kg.

System Boundaries	
Nature Boundary	Regulated missions to air from combustion of the fuel are included. The parameters that are presented are: - Regulated emissions for diesel engines:NOx, HC, Particles and CO - Fuel regulated: SO_2 - Tax regulated CO_2 Other environmental impacts, e.g., diffuse emissions to air, emissions to water and ground, noise, encroachment, from the operation of the aircraft are not included.
Time Boundary	The data represents aircrafts in use in 2000.
Geographical Boundary	Data is based on Swedish and European conditions.
Other Boundaries	The distance chosen is 1200 km, which is a typical distance for domestic goods transport flights in Sweden. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. Parameters not considered: External conditions i.e. climate etc. Maintenance level of the aircraft. Excluded subsystems: Precombustion i.e. production and distribution of fuels Maintanence and aftertreatment of the aircraft Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	NTM
Method	For the calculation of emissions from the jet plane (Airbus A 300-B4), the flight simulation method of the Aerotechnical Research Station (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% of the aircrafts maximum payload capacity , ''min'' implies a utilisation level of 100% and ''max'' 50%.
Literature Reference	ICAO Engine Exhaust Emissions Data Bank, Doc 9646-AN/943, (1995). Simos D, 1997, PIANO, Project Interactive Analysis and Optimizartion, Users Guide, Lissys Ltd, Woodhouse Eaves LE 12 8RL, UK Näs P, 1998, Aircraft Engine Emissions and Operational Procedures - Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, FFA, Bromma, Sweden
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Kerosene	3.15	2.54	4.27	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	37.3	27.7	55.7	g	Air	Sweden
	Output	Emission	CO2	883	671	1128	g	Air	Sweden
	Output	Emission	HC	4.22	3.14	6.30	g	Air	Sweden
	Output	Emission	NOx	4.21	3.58	5.29	g	Air	Sweden
	Output	Emission	Particles				g	Air	Sweden
	Output	Emission	SO2	0.26	0.21	0.36	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.

Commissioner	- NTM.
Practitioner	Pålsson, Anette - FFA, Bromma .
Reviewer	None, to be reviewed. -
Applicability	The emissions vary considerably between different types of aircraft and engine combinations. Thus, the emission data given in this context are only applicable to the specific type of aircraft and distances of this example. Provided that the plane types presented in this context are representative for their categories (size and age), the figures may be used for estimations of total emissions from a certain traffic volume. The total amount of emissions depends on a number of parameters of which the most important are starting weight and transportation distance. The longer the distance, the higher the emissions per flight, but lower per tonkm, since take-off and landing always have to take place in a flight. The distance chosen is 1200 km, which is a typical distance for flights for goods transport in Europe. The aircraft presented is a version that carries only goods. It is commonly used for goods transport in Sweden and in Europe. It is a large jet with 2 engines and in a passenger version it would carry almost 270 passengers. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. For calculations of emissions from flights of other distances than the ones given, the following relations can be used. They apply to flights of distances between 600 - 1200 km, with Airbus A 300-B4. Total emissions = Constant emission (kg) + Variable emission (kg/km) * distance (km) 50% payload: Constant emission CO2=2171 NOX=11,1 HC=0,34 CO=6,1 Variable emission CO2=9,10 NOX=0,030 HC=0,0003 CO=0,012 75% Payload: Costant emission CO2=2554 NOX=13,3 HC=0,36 CO=6,3 Variable emission CO2=9,35 NOX=0,031 HC=0,0003 CO=0,124 100% Payload: Constant emission CO2=3302 NOX=17,6 HC=0,375 CO=6,532 Variable emission CO2=9,48 NOX=0,032 HC=0,0003 CO=0,012
About Data	Data are calculated from the simulation method of the Aeronautical Research Institute of Sweden (FFA). For the calculation of emissions from the jet plane (Airbus A 300-B4), the flight simulation method of the Aeronautical Research Institute of Sweden (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a

	database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. References: - ICAO Engine Exhaust Emissions Data Bank, Doc 9646 AN/943, (1995) - Dimitri Simos, PIANO, Project Interactive Analysis and Optimization, User's Guide, Lissys Limited, Woodhouse Eaves LE 12 8RL, United Kingdom 1997 - Patrik Näs, Aircraft Engine Emissions and Operational Procedures – Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, Bromma, 1998
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by plane in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Jet plane, A 300-B4, 600 km

Administrative	
Finished	Y
Date Completed	1999 - 12
Copyright	NTM
Availability	Public

Technical System	
Name	Jet plane, A 300-B4, 600 km
Functional Unit	1 tonkm, 75 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 km calculated for 600 km flight distance and an average utilisation level equivalent to 75 % of the aircrafts maximum payload capacity.
Process Type	Gate to gate
Site	Sweden
Sector	Air transport
Owner	Sweden
Technical system description	Operation of jet plane, type Airbus A 300-B4 with 2 engines Rolls Royce RB211-524, 600 km, Swedish domestic flight, with 8 minutes of taxiing and landing run (3 min. in and 5 min. out). This is a larger plane, with a capacity of approximately 270 passengers in a passenger version. The plane presented here, however, is strictly a freight version which seats no passengers. Utilisation level is set to 75% for the medium quantity, 100% for ''min'' and 50% for ''max''. Fuel: Jet-A1. Takeoff Weight (TOW): 170 tons. Speed (cruise): 897 km/h. Maximum payload 45 000 kg.

System Boundaries

Nature Boundary	Regulated missions to air from combustion of the fuel are included. The parameters that are presented are: - Regulated emissions for diesel engines:NOx, HC, Particles and CO - Fuel regulated: SO2 - Tax regulated CO2 Other environmental impacts, e.g., diffuse emissions to air, emissions to water and ground, noise, encroachment, from the operation of the aircraft are not included.
Time Boundary	The data represents aircrafts in use in 2000.
Geographical Boundary	Data is based on Swedish and European conditions.
Other Boundaries	The distance chosen is 600 km, which is a typical distance for domestic goods transport flights in Sweden. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. Parameters not considered: External conditions i.e. climate etc. Maintenance level of the aircraft. Excluded subsystems: Precombustion i.e. production and distribution of fuels Maintanence and aftertreatment of the aircraft Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	NTM
Method	For the calculation of emissions from the jet plane (Airbus A 300-B4), the flight simulation method of the Aerotechnical Research Station (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% of the aircrafts maximum payload capacity , ''min'' implies a utilisation level of 100% and ''max'' 50%.
Literature Reference	ICAO Engine Exhaust Emissions Data Bank, Doc 9646-AN/943, (1995). Simos D, 1997, PIANO, Project Interactive Analysis and Optimizartion, Users Guide, Lissys Ltd, Woodhouse Eaves LE 12 8RL, UK Näs P, 1998, Aircraft Engine Emissions and Operational Procedures - Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, FFA, Bromma, Sweden
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Kerosene	3.86	3.13	4.87	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	74.4	55.3	111.1	g	Air	Sweden
	Output	Emission	CO2	1021	828	1287	g	Air	Sweden
	Output	Emission	HC	8.43	6.27	12.57	g	Air	Sweden
	Output	Emission	NOx	6.26	5.22	7.26	g	Air	Sweden
	Output	Emission	Particles				g	Air	Sweden
	Output	Emission	SO2	0.32	0.26	0.41	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology

	Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Pålsson, Anette - FFA, Bromma .
Reviewer	None, to be reviewed. -
Applicability	The emissions vary considerably between different types of aircraft and engine combinations. Thus, the emission data given in this context are only applicable to the specific type of aircraft and distances of this example. Provided that the plane types presented in this context are representative for their categories (size and age), the figures may be used for estimations of total emissions from a certain traffic volume. The total amount of emissions depends on a number of parameters of which the most important are starting weight and transportation distance. The longer the distance, the higher the emissions per flight, but lower per tonkm, since take-off and landing always have to take place in a flight. The distance chosen is 600 km, which is a typical distance for domestic flights for goods transport in Sweden. The aircraft presented is a version that carries only goods. It is commonly used for goods transport in Sweden and in Europe. It is a large jet with 2 engines and in a passenger version it would carry almost 270 passengers. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. For calculations of emissions from flights of other distances than the ones given, the following relations can be used. They apply to flights of distances between 600 - 1200 km, with Airbus A 300-B4. Total emissions = Constant emission (kg) + Variable emission (kg/km) * distance (km) 50% payload: Constant emission CO_2=2171 NO_X=11,1 HC=0,34 CO=6,1 Variable emission CO_2=9,10 NO_X=0,030 HC=0,0003 CO=0,012

	75% Payload: Costant emission CO2=2554 NOX=13,3 HC=0,36 CO=6,3 Variable emission CO2=9,35 NOX=0,031 HC=0,0003 CO=0,124 100% Payload: Constant emission CO2=3302 NOX=17,6 HC=0,375 CO=6,532 Variable emission CO2=9,48 NOX=0,032 HC=0,0003 CO=0,012
About Data	Data are calculated from the simulation method of the Aeronautical Research Institute of Sweden (FFA). For the calculation of emissions from the jet plane (Airbus A 300-B4), the flight simulation method of the Aeronautical Research Institute (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. References: - ICAO Engine Exhaust Emissions Data Bank, Doc 9646 AN/943, (1995) - Dimitri Simos, PIANO, Project Interactive Analysis and Optimization, User's Guide, Lissys Limited, Woodhouse Eaves LE 12 8RL, United Kingdom 1997 - Patrik Näs, Aircraft Engine Emissions and Operational Procedures – Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, Bromma, 1998
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by plane in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Jet plane, B727-200, 1200 km

Administrative	
Finished	Y
Date Completed	1999 - 12
Copyright	NTM
Availability	Public

Technical System

Name	Jet plane, B727-200, 1200 km
Functional Unit	1 tonkm, 75 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 km calculated for 1200 km flight distance and an average utilisation level equivalent to 75 % of the aircrafts maximum payload capacity.
Process Type	Gate to gate
Site	Sweden
Sector	Air transport
Owner	Sweden
Technical system description	Operation of jet plane, type Boeing B727-200 with 3 engines Pratt&Whitney JT8D-9, 1200 km, european flight, with 8 minutes of taxiing and landing run (3 min. in and 5 min. out). The plane is somewhat older, but still regular in freight transports. In a passenger version, the plane can seat approximately 200 passengers. The plane presented here, however, is strictly a freight version which seats no passengers. Utilisation level is set to 75% for the medium quantity, 100% for ''min'' and 50% for ''max''. Fuel: Jet-A1. Takeoff Weight (TOW): 83,8 tons. Speed (cruise): 965 km/h. Maximum payload 45 000 kg.

System Boundaries

Nature Boundary	Regulated missions to air from combustion of the fuel are included. The parameters that are presented are: - Regulated emissions for diesel engines:NOx, HC, Particles and CO - Fuel regulated: SO2 - Tax regulated CO2 Other environmental impacts, e.g., diffuse emissions to air, emissions to water and ground, noise, encroachment, from the operation of the aircraft are not included.
Time Boundary	The data represents aircrafts in use in 2000.
Geographical Boundary	Data is based on Swedish and European conditions.
Other Boundaries	The distance chosen is 1200 km, which is a typical distance for goods transport flights in Europe. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. Parameters not considered: External conditions i.e. climate etc. Maintenance level of the aircraft. Excluded subsystems: Precombustion i.e. production and distribution of fuels Maintanence and aftertreatment of the aircraft Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1999-12-01
Data Type	Derived, unspecified
Represents	NTM
Method	For the calculation of emissions from the jet plane (Boeing 727-200), the flight simulation method of the Aerotechnical Research Station (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% of the aircrafts maximum payload capacity , ''min'' implies a utilisation level of 100% and ''max'' 50%.

Literature Reference	ICAO Engine Exhaust Emissions Data Bank, Doc 9646-AN/943, (1995). Simos D, 1997, PIANO, Project Interactive Analysis and Optimizartion, Users Guide, Lissys Ltd, Woodhouse Eaves LE 12 8RL, UK Näs P, 1998, Aircraft Engine Emissions and Operational Procedures - Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, FFA, Bromma, Sweden
Notes	

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Kerosene	4.07	3.18	5.76	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	2.6	1.8	4.0	g	Air	Sweden
	Output	Emission	CO2	1077	842	1524	g	Air	Sweden
	Output	Emission	HC	0.60	0.44	0.91	g	Air	Sweden
	Output	Emission	NOx	3.79	3.09	5.15	g	Air	Sweden
	Output	Emission	Particles				g	Air	Sweden
	Output	Emission	SO2	0.34	0.27	0.27	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Pålsson, Anette - FFA, Bromma .
Reviewer	None, to be reviewed. -
Applicability	The emissions vary considerably between different types of aircraft and engine combinations. Thus, the emission data given in this context are only applicable to the specific type of aircraft and distances of this example. Provided that the plane types presented in this context are representative for their categories (size and age), the figures may be used for estimations of total emissions from a certain traffic volume. The total amount of emissions depends on a number of parameters of which the most important are starting weight and transportation distance. The longer the distance, the higher the emissions per flight, but lower per tonkm, since take-off and landing always have to take place in a flight.

	The distance chosen is 1200 km, which is a typical distance for domestic flights for goods transport in Europe. The aircraft presented is a version that carries only goods. It is a rather old version, but still rather commonly used for goods transport in Sweden and in Europe. It is a jet with 3 engines and in a passenger version it would carry 200 passengers. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. For calculations of emissions from flights of other distances than the ones given, the following relations can be used. They apply to flights of distances between 600 - 1200 km, with Boeing 727-200. Total emissions = Constant emission (kg) + Variable emission (kg/km) * distance (km) 50% payload: Constant emission CO2=4027 NOX=22,2 HC=3,39 CO=9,7 Variable emission CO2=14,93 NOX=0,043 HC=0,0081 CO=0,040 75% Payload: Costant emission CO2=4727 NOX=26,5 HC=3,41 CO=9,2 Variable emission CO2=15,44 NOX=0,046 HC=0,008 CO=0,0389 100% Payload: Constant emission CO2=5829 NOX=32,275 HC=3,638 CO=9,654 Variable emission CO2=15,36 NOX=0,047 HC=0,0075 CO=0,036
About Data	Data are calculated from the simulation method of the Aeronautical Research Institute of Sweden (FFA). For the calculation of emissions from the jet plane (Boeing 727-200), the flight simulation method of the Aeronautical Research Institute (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. References: - ICAO Engine Exhaust Emissions Data Bank, Doc 9646 AN/943, (1995) - Dimitri Simos, PIANO, Project Interactive Analysis and Optimization, User's Guide, Lissys Limited, Woodhouse Eaves LE 12 8RL, United Kingdom 1997 - Patrik Näs, Aircraft Engine Emissions and Operational Procedures – Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, Bromma, 1998

Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by plane in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Jet plane, B727-200, 600 km

Administrative	
Finished	Y
Date Completed	1999 - 12
Copyright	NTM
Availability	Public

Technical System	
Name	Jet plane, B727-200, 600 km
Functional Unit	1 tonkm, 75 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 km calculated for 600 km flight distance and an average utilisation level equivalent to 75 % of the aircrafts maximum payload capacity.
Process Type	Gate to gate
Site	Sweden
Sector	Air transport
Owner	Sweden
Technical system description	Operation of jet plane, type Boeing B727-200 with 3 engines Pratt&Whitney JT8D-9, 600 km, Swedish domestic flight, with 8 minutes of taxiing and landing run (3 min. in and 5 min. out). The plane is somewhat older, but still regular in freight transports. In a passenger version, the plane can seat approximately 200 passengers. The plane presented here, however, is strictly a freight version which seats no passengers. Utilisation level is set to 75% for the medium quantity, 100% for ''min'' and 50% for ''max''. Fuel: Jet-A1. Takeoff Weight (TOW): 83,8 tons. Speed (cruise): 965 km/h. Maximum payload 45 000 kg.

System Boundaries	
Nature Boundary	Regulated missions to air from combustion of the fuel are included. The parameters that are presented are: - Regulated emissions for diesel engines:NOx, HC, Particles and CO - Fuel regulated: SO2 - Tax regulated CO2 Other environmental impacts, e.g., diffuse emissions to air, emissions to water and ground, noise, encroachment, from the operation of the aircraft are not included.
Time Boundary	The data represents aircrafts in use in 2000.
Geographical Boundary	Data is based on Swedish and European conditions.
Other Boundaries	The distance chosen is 600 km, which is a typical distance for domestic goods transport flights in Sweden. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%.

	Parameters not considered: External conditions i.e. climate etc. Maintenance level of the aircraft. Excluded subsystems: Precombustion i.e. production and distribution of fuels Maintanence and aftertreatment of the aircraft Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1999 - 12
Data Type	Derived, unspecified
Represents	NTM
Method	For the calculation of emissions from the jet plane (Boeing 727-200), the flight simulation method of the Aerotechnical Research Station (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% of the aircrafts maximum payload capacity , ''min'' implies a utilisation level of 100% and ''max'' 50%.
Literature Reference	ICAO Engine Exhaust Emissions Data Bank, Doc 9646-AN/943, (1995). Simos D, 1997, PIANO, Project Interactive Analysis and Optimizartion, Users Guide, Lissys Ltd, Woodhouse Eaves LE 12 8RL, UK Näs P, 1998, Aircraft Engine Emissions and Operational Procedures - Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, FFA, Bromma, Sweden
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Kerosene	4.90	3.95	6.82	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	3.0	2.2	4.7	g	Air	Sweden
	Output	Emission	CO2	1295	1045	1804	g	Air	Sweden
	Output	Emission	HC	0.76	0.57	1.15	g	Air	Sweden
	Output	Emission	NOx	5.02	4.21	6.69	g	Air	Sweden
	Output	Emission	Particles				g	Air	Sweden
	Output	Emission	SO2	0.41	0.33	0.57	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage

	Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Pålsson, Anette - FFA, Bromma .
Reviewer	None, to be reviewed. -
Applicability	The emissions vary considerably between different types of aircraft and engine combinations. Thus, the emission data given in this context are only applicable to the specific type of aircraft and distances of this example. Provided that the plane types presented in this context are representative for their categories (size and age), the figures may be used for estimations of total emissions from a certain traffic volume. The total amount of emissions depends on a number of parameters of which the most important are starting weight and transportation distance. The longer the distance, the higher the emissions per flight, but lower per tonkm, since take-off and landing always have to take place in a flight. The distance chosen is 600 km, which is a typical distance for domestic flights for goods transport in Sweden. The aircraft presented is a version that carries only goods. It is a rather old version, but still rather commonly used for goods transport in Sweden and in Europe. It is a jet with 3 engines and in a passenger version it would carry 200 passengers. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. For calculations of emissions from flights of other distances than the ones given, the following relations can be used. They apply to flights of distances between 600 - 1200 km, with Boeing 727-200. Total emissions = Constant emission (kg) + Variable emission (kg/km) * distance (km) 50% payload: Constant emission CO2=4027 NOX=22,2 HC=3,39 CO=9,7 Variable emission CO2=14,93 NOX=0,043 HC=0,0081 CO=0,040 75% Payload: Costant emission CO2=4727 NOX=26,5 HC=3,41 CO=9,2 Variable emission CO2=15,44 NOX=0,046 HC=0,008 CO=0,0389 100% Payload:

	Constant emission CO_2=5829 NO_X=32,275 HC=3,638 CO=9,654 Variable emission CO_2=15,36 NO_X=0,047 HC=0,0075 CO=0,036
About Data	Data are calculated from the simulation method of the Aeronautical Research Institute of Sweden (FFA). For the calculation of emissions from the jet plane (Boeing 727-200), the flight simulation method of the Aeronautical Research Institute (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. References: - ICAO Engine Exhaust Emissions Data Bank, Doc 9646 AN/943, (1995) - Dimitri Simos, PIANO, Project Interactive Analysis and Optimization, User's Guide, Lissys Limited, Woodhouse Eaves LE 12 8RL, United Kingdom 1997 - Patrik Näs, Aircraft Engine Emissions and Operational Procedures – Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, Bromma, 1998
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by plane in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Jet plane, B737-300QC, 1200 km

Administrative	
Finished	Y
Date Completed	1999 - 12
Copyright	NTM
Availability	Public

Technical System	
Name	Jet plane, B737-300QC, 1200 km
Functional Unit	1 tonkm, 75 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 km calculated for 1200 km flight distance and an average utilisation level equivalent to 75 % of the aircrafts maximum payload capacity.
Process Type	Gate to gate
Site	Sweden
Sector	Air transport

Owner	Sweden
Technical system description	Operation of an airplane, type Boeing B737-300QC with 2 engines General Electric CFM56-3C-1, 600 km, Swedish domestic flight, with 8 minutes of taxiing and landing run (3 min. in and 5 min. out). In a passenger version, the plane can seat almost 150 passengers. The plane presented here, however, is strictly a freight version which seats no passengers. Utilisation level is set to 75% for the medium quantity, 100% for ''min'' and 50% for ''max''. Fuel: Jet-A1. Takeoff Weight (TOW): 60 tons. Speed (cruise): 820 km/h. Maximum payload 17 700 kg.

System Boundaries

Nature Boundary	Regulated missions to air from combustion of the fuel are included. The parameters that are presented are: - Regulated emissions for diesel engines:NOx, HC, Particles and CO - Fuel regulated: SO2 - Tax regulated CO2 Other environmental impacts, e.g., diffuse emissions to air, emissions to water and ground, noise, encroachment, from the operation of the aircraft are not included.
Time Boundary	The data represents aircrafts in use in 2000.
Geographical Boundary	Data is based on Swedish and European conditions.
Other Boundaries	The distance chosen is 1200 km, which is a typical distance for goods transport flights in Europe. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. Parameters not considered: External conditions i.e. climate etc. Maintenance level of the aircraft. Excluded subsystems: Precombustion i.e. production and distribution of fuels Maintanence and aftertreatment of the aircraft Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	NTM
Method	For the calculation of emissions from the jet plane (Boeing 737-300QC), the flight simulation method of the Aerotechnical Research Station (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% of the aircrafts maximum payload capacity , ''min'' implies a utilisation level of 100% and ''max'' 50%.
Literature Reference	ICAO Engine Exhaust Emissions Data Bank, Doc 9646-AN/943, (1995). Simos D, 1997, PIANO, Project Interactive Analysis and Optimizartion, Users Guide, Lissys Ltd, Woodhouse Eaves LE 12 8RL, UK Näs P, 1998, Aircraft Engine Emissions and Operational Procedures - Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, FFA, Bromma, Sweden
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Kerosene	3.27	2.61	4.66	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	1.3	1.0	2.0	g	Air	Sweden
	Output	Emission	CO2	906	724	1292	g	Air	Sweden
	Output	Emission	HC	0.045	0.035	0.066	g	Air	Sweden

	Output	Emission	NOx	3.57	2.93	4.97	g	Air	Sweden
	Output	Emission	Particles				g	Air	Sweden
	Output	Emission	SO2	0.50	0.40	0.71	g	Air	Sweden

About Inventory	
Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Pålsson, Anette - FFA, Bromma .
Reviewer	None, to be reviewed. -
Applicability	The emissions vary considerably between different types of aircraft and engine combinations. Thus, the emission data given in this context are only applicable to the specific type of aircraft and distances of this example. Provided that the plane types presented in this context are representative for their categories (size and age), the figures may be used for estimations of total emissions from a certain traffic volume. The total amount of emissions depends on a number of parameters of which the most important are starting weight and transportation distance. The longer the distance, the higher the emissions per flight, but lower per tonkm, since take-off and landing always have to take place in a flight. The distance chosen is 1200 km, which is a typical distance for domestic flights for goods transport in Sweden. The aircraft presented is a version that carries only goods. It is commonly used for goods transport in Sweden and in Europe. It is a middle-sized jet with 2 engines and in a passenger version it would carry almost 150 passengers. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. For calculations of emissions from flights of other distances than the ones given, the following relations can be used. They apply to flights of distances between 600 - 1200 km, with Boeing 737-300QC. Total emissions = Constant emission (kg) + Variable emission (kg/km) * distance (km)

	50% payload: Constant emission CO2=2171 NOX=11,1 HC=0,34 CO=6,1 Variable emission CO2=9,10 NOX=0,030 HC=0,0003 CO=0,012 75% Payload: Costant emission CO2=2554 NOX=13,3 HC=0,0003 CO=0,0124 Variable emission CO2=9,35 NOX=13,3 HC=0,36 CO=6,3 100% Payload: Constant emission CO2=3302 NOX=17,6 HC=0,375 CO=6,532 Variable emission CO2=9,48 NOX=0,032 HC=0,0003 CO=0,012
About Data	Data are calculated from the simulation method of the Aeronautical Research Institute of Sweden (FFA). For the calculation of emissions from the jet plane (Boeing 737-300QC), the flight simulation method of the Aeronautical Research Institute (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. References: - ICAO Engine Exhaust Emissions Data Bank, Doc 9646 AN/943, (1995) - Dimitri Simos, PIANO, Project Interactive Analysis and Optimization, User's Guide, Lissys Limited, Woodhouse Eaves LE 12 8RL, United Kingdom 1997 - Patrik Näs, Aircraft Engine Emissions and Operational Procedures – Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, Bromma, 1998
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by plane in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Jet plane, B737-300QC, 600 km

Administrative	
Finished	Y
Date Completed	1999 - 12
Copyright	NTM
Availability	Public

Technical System	
Name	Jet plane, B737-300QC, 600 km
Functional Unit	1 tonkm, 75 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 km calculated for 600 km flight distance and an average utilisation level equivalent to 75 % of the aircrafts maximum payload capacity.
Process Type	Gate to gate
Site	Sweden
Sector	Air transport
Owner	Sweden
Technical system description	Operation of jet plane, type Boeing B737-300QC with 2 engines General Electric CFM56-3C-1, 600 km, Swedish domestic flight, with 8 minutes of taxiing and landing run (3 min. in and 5 min. out). In a passenger version, the plane can seat almost 150 passengers. The plane presented here, however, is strictly a freight version which seats no passengers. Utilisation level is set to 75% for the medium quantity, 100% for ''min'' and 50% for ''max''. Fuel: Jet-A1. Takeoff Weight (TOW): 60 tons. Speed (cruise): 820 km/h. Maximum payload 17 700 kg.

System Boundaries	
Nature Boundary	Regulated missions to air from combustion of the fuel are included. The parameters that are presented are: - Regulated emissions for diesel engines:NOx, HC, Particles and CO - Fuel regulated: SO2 - Tax regulated CO2 Other environmental impacts, e.g., diffuse emissions to air, emissions to water and ground, noise, encroachment, from the operation of the aircraft are not included.
Time Boundary	The data represents aircrafts in use in 2000.
Geographical Boundary	Data is based on Swedish and European conditions.
Other Boundaries	The distance chosen is 600 km, which is a typical distance for domestic goods transport flights in Sweden. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. Parameters not considered: External conditions i.e. climate etc. Maintenance level of the aircraft. Excluded subsystems: Precombustion i.e. production and distribution of fuels Maintanence and aftertreatment of the aircraft Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	Derived, unspecified
Represents	NTM

Method	For the calculation of emissions from the jet plane (Boeing 737-300QC), the flight simulation method of the Aerotechnical Research Station (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% of the aircrafts maximum payload capacity , ''min'' implies a utilisation level of 100% and ''max'' 50%.
Literature Reference	ICAO Engine Exhaust Emissions Data Bank, Doc 9646-AN/943, (1995). Simos D, 1997, PIANO, Project Interactive Analysis and Optimizartion, Users Guide, Lissys Ltd, Woodhouse Eaves LE 12 8RL, UK Näs P, 1998, Aircraft Engine Emissions and Operational Procedures - Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, FFA, Bromma, Sweden
Notes	

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Kerosene	0			kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	1.7	1.3	2.5	g	Air	Sweden
	Output	Emission	CO2	1074	887	1505	g	Air	Sweden
	Output	Emission	HC	0.65	0.49	0.81	g	Air	Sweden
	Output	Emission	NOx	4.47	3.83	6.10	g	Air	Sweden
	Output	Emission	Particles				g	Air	Sweden
	Output	Emission	SO2	0.59	0.49	0.83	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Pålsson, Anette - FFA, Bromma .
Reviewer	None, to be reviewed. -

Applicability	The emissions vary considerably between different types of aircraft and engine combinations. Thus, the emission data given in this context are only applicable to the specific type of aircraft and distances of this example. Provided that the plane types presented in this context are representative for their categories (size and age), the figures may be used for estimations of total emissions from a certain traffic volume. The total amount of emissions depends on a number of parameters of which the most important are starting weight and transportation distance. The longer the distance, the higher the emissions per flight, but lower per tonkm, since take-off and landing always have to take place in a flight. The distance chosen is 600 km, which is a typical distance for domestic flights for goods transport in Sweden. The aircraft presented is a version that carries only goods. It is commonly used for goods transport in Sweden and in Europe. It is a middle-sized jet with 2 engines and in a passenger version it would carry almost 150 passengers. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. For calculations of emissions from flights of other distances than the ones given, the following relations can be used. They apply to flights of distances between 600 - 1200 km, with Boeing 737-300QC. Total emissions = Constant emission (kg) + Variable emission (kg/km) * distance (km) 50% payload: Constant emission CO2=2171 NOX=11,1 HC=0,34 CO=6,1 Variable emission CO2=9,10 NOX=0,030 HC=0,0003 CO=0,012 75% Payload: Costant emission CO2=2554 NOX=13,3 HC=0,0003 CO=0,0124 Variable emission CO2=9,35 NOX=13,3 HC=0,36 CO=6,3 100% Payload: Constant emission CO2=3302 NOX=17,6 HC=0,375 CO=6,532 Variable emission CO2=9,48 NOX=0,032 HC=0,0003 CO=0,012
About Data	Data are calculated from the simulation method of the Aeronautical Research Institute of Sweden (FFA). For the calculation of emissions from the jet plane (Boeing 737-300QC), the flight simulation method of the Aeronautical Research Institute (FFA) has been used. FFA has used a software tool 'PIANO', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. References: - ICAO Engine Exhaust Emissions Data Bank, Doc 9646 AN/943, (1995) - Dimitri Simos, PIANO, Project Interactive Analysis and Optimization, User's Guide, Lissys Limited, Woodhouse Eaves LE 12 8RL, United Kingdom 1997

	- Patrik Näs, Aircraft Engine Emissions and Operational Procedures – Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, Bromma, 1998
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by plane in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Jet plane, B747-400, 1200 km

Administrative	
Finished	Y
Date Completed	1999 - 12
Copyright	NTM
Availability	Public

Technical System	
Name	Jet plane, B747-400, 1200 km
Functional Unit	1 tonkm, 75 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 km calculated for 1200 km flight distance and an average utilisation level equivalent to 75 % of the aircrafts maximum payload capacity.
Process Type	Gate to gate
Site	Sweden
Sector	Air transport
Owner	Sweden
Technical system description	Operation of jet plane, type Boeing B747-400 with 4 engines General Electric CF6-80C2A3, 1200 km, European flight, with 8 minutes of taxiing and landing run (3 min. in and 5 min. out). The plane is a jumbojet, which in a passenger version seats more than 400 passengers. The plane presented here, however, is strictly a freight version which seats no passengers. Utilisation level is set to 75% for the medium quantity, 100% for ''min'' and 50% for ''max''. Fuel: Jet-A1. Takeoff Weight (TOW): 394,6 tons. Speed (cruise): 910 km/h. Maximum payload 93 000 kg.

System Boundaries	
Nature Boundary	Regulated missions to air from combustion of the fuel are included. The parameters that are presented are: - Regulated emissions for diesel engines:NOx, HC, Particles and CO - Fuel regulated: SO2 - Tax regulated CO2 Other environmental impacts, e.g., diffuse emissions to air, emissions to water and ground, noise, encroachment, from the operation of the aircraft are not included.
Time Boundary	The data represents aircrafts in use in 2000.
Geographical Boundary	Data is based on Swedish and European conditions.

Other Boundaries	The distance chosen is 1200 km, which is a typical distance for goods transport flights in Europe. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. Parameters not considered: External conditions i.e. climate etc. Maintenance level of the aircraft. Excluded subsystems: Precombustion i.e. production and distribution of fuels Maintanence and aftertreatment of the aircraft Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	NTM
Method	For the calculation of emissions from the jet plane (Boeing 747-200), the flight simulation method of the Aerotechnical Research Station (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% of the aircrafts maximum payload capacity , ''min'' implies a utilisation level of 100% and ''max'' 50%.
Literature Reference	ICAO Engine Exhaust Emissions Data Bank, Doc 9646-AN/943, (1995). Simos D, 1997, PIANO, Project Interactive Analysis and Optimizartion, Users Guide, Lissys Ltd, Woodhouse Eaves LE 12 8RL, UK Näs P, 1998, Aircraft Engine Emissions and Operational Procedures - Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, FFA, Bromma, Sweden
Notes	

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Kerosene	2.09	-	3.08	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.7	-	1.1	g	Air	Sweden
	Output	Emission	CO2	552	-	814	g	Air	Sweden
	Output	Emission	HC	0.062	-	1.1	g	Air	Sweden
	Output	Emission	NOx	5.69	-	8.76	g	Air	Sweden
	Output	Emission	Particles				g	Air	Sweden
	Output	Emission	SO2	0.17	-	0.26	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business.

	The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Pålsson, Anette - FFA, Bromma .
Reviewer	None, to be reviewed. -
Applicability	The emissions vary considerably between different types of aircraft and engine combinations. Thus, the emission data given in this context are only applicable to the specific type of aircraft and distances of this example. Provided that the plane types presented in this context are representative for their categories (size and age), the figures may be used for estimations of total emissions from a certain traffic volume. The total amount of emissions depends on a number of parameters of which the most important are starting weight and transportation distance. The longer the distance, the higher the emissions per flight, but lower per tonkm, since take-off and landing always have to take place in a flight. The distance chosen is 1200 km, which is a typical distance for European flights for goods transport in Sweden. The aircraft presented is a version that carries only goods. It is commonly used for goods transport in Sweden and in Europe. It is a large (Jumbo) jet with 4 engines and in a passenger version it would carry more than 400 passengers. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. For calculations of emissions from flights of other distances than the ones given, the following relations can be used. They apply to flights of distances between 600 - 1200 km, with Boeing 747-200. Total emissions = Constant emission (kg) + Variable emission (kg/km) * distance (km) 50% payload: Constant emission CO2=5905 NOX=162,4 HC=0,0002 CO=0,020 Variable emission CO2=32,93 NOX=0,272 HC=0,0002 CO=0,020 75% Payload: Costant emission CO2=920 NOX=65,2 HC=4,91 CO=31,2 Variable emission CO2=37,7 NOX=0,342

	HC=0,0002 CO=0,0205 100% Payload: Constant emission CO2=-2469 NOX=72,2 HC=4,8798 CO=29,338 Variable emission CO2=43,30 NOX=0,407 HC=0,0002 CO=0,023
About Data	Data are calculated from the simulation method of the Aeronautical Research Institute of Sweden (FFA). For the calculation of emissions from the jet plane (Boeing 747-200), the flight simulation method of the Aeronautical Research Institute (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. References: - ICAO Engine Exhaust Emissions Data Bank, Doc 9646 AN/943, (1995) - Dimitri Simos, PIANO, Project Interactive Analysis and Optimization, User's Guide, Lissys Limited, Woodhouse Eaves LE 12 8RL, United Kingdom 1997 - Patrik Näs, Aircraft Engine Emissions and Operational Procedures – Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, Bromma, 1998
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by plane in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Jet plane, B747-400, 600 km

Administrative	
Finished	Y
Date Completed	1999 - 12
Copyright	NTM
Availability	Public

Technical System	
Name	Jet plane, B747-400, 600 km
Functional Unit	1 tonkm, 75 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 km calculated for 600 km flight distance and an average utilisation level equivalent to 75 % of the aircrafts maximum payload capacity.

Process Type	Gate to gate
Site	Sweden
Sector	Air transport
Owner	Sweden
Technical system description	Operation of jet plane, type Boeing B747-400 with 4 engines General Electric CF6-80C2A3, 600 km, Swedish domestic flight, with 8 minutes of taxiing and landing run (3 min. in and 5 min. out). The plane is a jumbojet, which in a passenger version seats more than 400 passengers. The plane presented here, however, is strictly a freight version which seats no passengers. Utilisation level is set to 75% for the medium quantity, 100% for ''min'' and 50% for ''max''. Fuel: Jet-A1. Takeoff Weight (TOW): 394,6 tons. Speed (cruise): 910 km/h. Maximum payload 93 000 kg.

System Boundaries	
Nature Boundary	Regulated missions to air from combustion of the fuel are included. The parameters that are presented are: - Regulated emissions for diesel engines:NOx, HC, Particles and CO - Fuel regulated: SO2 - Tax regulated CO2 Other environmental impacts, e.g., diffuse emissions to air, emissions to water and ground, noise, encroachment, from the operation of the aircraft are not included.
Time Boundary	The data represents aircrafts in use in 2000.
Geographical Boundary	Data is based on Swedish and European conditions.
Other Boundaries	The distance chosen is 600 km, which is a typical distance for domestic goods transport flights in Sweden. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of 100% and ''max'' 50%. Parameters not considered: External conditions i.e. climate etc. Maintenance level of the aircraft. Excluded subsystems: Precombustion i.e. production and distribution of fuels Maintanence and aftertreatment of the aircraft Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	Derived, unspecified
Represents	NTM
Method	For the calculation of emissions from the jet plane (Boeing 747-200), the flight simulation method of the Aerotechnical Research Station (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% of the aircrafts maximum payload capacity , ''min'' implies a utilisation level of 100% and ''max'' 50%.
Literature Reference	ICAO Engine Exhaust Emissions Data Bank, Doc 9646-AN/943, (1995). Simos D, 1997, PIANO, Project Interactive Analysis and Optimizartion, Users Guide, Lissys Ltd, Woodhouse Eaves LE 12 8RL, UK Näs P, 1998, Aircraft Engine Emissions and Operational Procedures - Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, FFA, Bromma, Sweden
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*

	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Kerosene	2.13	1.59	3.48	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	1.0	0.8	1.7	g	Air	Sweden
	Output	Emission	CO2	563	421	920	g	Air	Sweden
	Output	Emission	HC	0.12	0.09	0.18	g	Air	Sweden
	Output	Emission	NOx	6.46	5.67	11.67	g	Air	Sweden
	Output	Emission	Particles				g	Air	Sweden
	Output	Emission	SO2	0.18	0.13	0.29	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Pålsson, Anette - FFA, Bromma .
Reviewer	None, to be reviewed. -
Applicability	The emissions vary considerably between different types of aircraft and engine combinations. Thus, the emission data given in this context are only applicable to the specific type of aircraft and distances of this example. Provided that the plane types presented in this context are representative for their categories (size and age), the figures may be used for estimations of total emissions from a certain traffic volume. The total amount of emissions depends on a number of parameters of which the most important are starting weight and transportation distance. The longer the distance, the higher the emissions per flight, but lower per tonkm, since take-off and landing always have to take place in a flight. The distance chosen is 600 km, which is a typical distance for domestic flights for goods transport in Sweden. The aircraft presented is a version that carries only goods. It is commonly used for goods transport in Sweden and in Europe. It is a large (Jumbo) jet with 4 engines and in a passenger version it would carry more than 400 passengers. The taxiing and landing run time chosen is 8 minutes (3 min. in, 5 min. out). Taxiing and loading run time depends mainly on the airport. The medium quantity implies a utilisation level of 75% , ''min'' implies a utilisation level of

	100% and ''max'' 50%. For calculations of emissions from flights of other distances than the ones given, the following relations can be used. They apply to flights of distances between 600 - 1200 km, with Boeing 747-200. Total emissions = Constant emission (kg) + Variable emission (kg/km) * distance (km) 50% payload: Constant emission CO2=5905 NOX=162,4 HC=0,0002 CO=0,020 Variable emission CO2=32,93 NOX=0,272 HC=0,0002 CO=0,020 75% Payload: Costant emission CO2=920 NOX=65,2 HC=4,91 CO=31,2 Variable emission CO2=37,7 NOX=0,342 HC=0,0002 CO=0,0205 100% Payload: Constant emission CO2=-2469 NOX=72,2 HC=4,8798 CO=29,338 Variable emission CO2=43,30 NOX=0,407 HC=0,0002 CO=0,023
About Data	Data are calculated from the simulation method of the Aeronautical Research Institute of Sweden (FFA). For the calculation of emissions from the jet plane (Boeing 747-200), the flight simulation method of the Aeronautical Research Institute (FFA) has been used. FFA has used a software tool ''PIANO'', developed for studies of aircraft design. The tool contains a database with aerodynamical data for different aircrafts and engines. The emission data is from ICAO emission database (ICAO,1995). The calculations in PIANO is calibrated after results from the EU-project AEROCERT (Näs P, 1998) in which samples from real life flights has been analysed. References: - ICAO Engine Exhaust Emissions Data Bank, Doc 9646 AN/943, (1995) - Dimitri Simos, PIANO, Project Interactive Analysis and Optimization, User's Guide, Lissys Limited, Woodhouse Eaves LE 12 8RL, United Kingdom 1997 - Patrik Näs, Aircraft Engine Emissions and Operational Procedures – Analysis of Flight Data Recorder for AEROCERT, FFA TN 1998-56, Bromma, 1998
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by plane in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: K30 ready mixed concrete production

Administrative	
Finished	Y
Date Completed	1996-10-01
Copyright	
Availability	Public

Technical System	
Name	K30 ready mixed concrete production
Functional Unit	kg
Functional Unit Explanation	1 kg of K30 ready mixed concrete
Process Type	Gate to gate
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	In this system cement, aggregates, additives and water are mixed to produce ready mixed concrete. The environmental load for the cement production is not considered in this set of data. Cement The cement is delivered from Cementas plant in Skövde, and storages in Vallhamn and Varberg. Transports are not accounted for. Aggregates Gravel 0-8 mm and stone 16-32 mm are used. The aggregates are delivered from Östad and Sjögärde, but the transport is not accounted for. Neither the energy use at the aggregate pit. Additives Air-entraining agent and plasticizer are normally used in the production. The air-entraining agent is bought from Sika in Järfälla while the plasticizer is purchased from Perstorp Chemitech in Perstorp.

System Boundaries	
Nature Boundary	
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	The concrete waste is crushed and used as filling masses at different urban developments, but it is not accounted for in this set of data. The environmental load for the cement production is not considered in this set of data, though it is to be found in this database, at Name: Production of cement Category: Cradle to gate Publication: LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund T., Tillman A-M.; Report 1997:2; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	NTM
Method	Inventory
Literature Reference	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden
Notes	The data type unspecified implies that one do not know what the data is based on. Inventory of the production of ready mixed concrete has been performed at two plants in Göteborg owned by Färdig betong AB.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Additives	0			g	Technosphere	
	Input	Natural resource	Aggregates	817			g	Technosphere	
	Input	Natural resource	Cement	118			g	Technosphere	
	Input	Natural resource	Electricity	0.015			MJ	Technosphere	
	Input	Natural resource	Oil (eo1)	0.017			MJ	Technosphere	
	Input	Natural resource	Water	80.1			g	Technosphere	
Notes: The density of K30 is calculated to 2 366 ton/m3.	Output	Product	K30-ready mixed concrete	1			kg	Technosphere	
Notes: Mineral waste consists of cncrete waste.	Output	Residue	Mineral waste	15			g	Technosphere	

About Inventory

Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden --- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology ---
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural concrete and steel frames in buildings during the whole life-cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of ready mixed concrete production K30.
Commissioner	- Finncement and Trätek (The Swedish Institute for Wood Technology Research) Box 5609 S-114 86 Stockholm Sweden.
Practitioner	Björklund T., Jönsson Å., Tillman A-M - Technical Environmental Planning, CTH Sven Hultins Gata 8 412 96 Göteborg Sweden .
Reviewer	
Applicability	To calculate the total environmental load, including the cement production, you can use the data in this Database at: Name: Production of cement Category:Cradle to gate Publication:LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund T., Tillman A-M.; Report 1997:2; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden The function of the technical system is not sufficently described. Contact Färdig betong AB Box 5162 402 26 Göteborg Sweden

	Phone +46 -31 7081500 to get the necessary details.
About Data	Aggregates It has to be noted that aggregates are considered to a nearly unlimited resource but in some parts of Sweden natural aggregates are very scarce. Substitutes are made from crushed blocks of stone to some greater energy expense compared to that of natural aggregates. In the study, all aggregates are regarded as natural aggregates. No calculation of energy use at the aggregate pit has been done. Additives Quantities of the admixtures are unknown, therefore, they are not taken into account. Water Water is taken from the community water system. It is in the study not regarded as a resource and is consequently not invented up-streams the flow. The density of K30 is calculated to 2 366 ton/m3. Waste Waste concrete from return deliveries and concrete from cleaning of the concrete mixer is reported to be 1.5 percent of the annual production. Transports not considered in this set of data: The cement is transported by truck about 160 km from Cementa's plant in Skövde to storages in Vallhamn and Varberg. The aggregates are delivered from Östad and Sjögärde, about 40 km by truck. The average distance to the customer is estimated to 30 km and the K30 is transported by truck.
Notes	-- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 18 September 2001: <<< Changes made by Ann-Christin Pålsson, CPM based on the original report Comments: The data for oil and electricity use have been corrected to be in accordance with the original report.

SPINE LCI dataset: K40 ready mixed concrete production

Administrative	
Finished	Y
Date Completed	1996-10-01
Copyright	
Availability	Public

Technical System	
Name	K40 ready mixed concrete production
Functional Unit	kg
Functional Unit Explanation	1 kg of K40 ready mixed concrete
Process Type	Gate to gate
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	In this system cement, aggregates, additives and water are mixed to produce ready mixed concrete. The environmental load for the cement production is not considered in this set of data. Cement

	The cement is delivered from Cementas plant in Skövde, and storages in Vallhamn and Varberg. Only cement produced in Skövde is used in this calculation. Transports are not accounted for. Aggregates Gravel 0-8 mm and stone 16-32 mm are used. The aggregates are delivered from Östad and Sjögärde, but the transport is not accounted for. Neither the energy use at the aggregate pit. Additives Air-entraining agent and plasticizer are normally used in the production. The air-entraining agent is bought from Sika in Järfälla while the plasticizer is purchased from Perstorp Chemitech in Perstorp.

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	The concrete waste is crushed and used as filling masses at different urban developments, but it is not accounted for in this set of data. The environmental load for the cement production is not considered in this set of data, though it is to be found in this database, at Name: Production of cement Category: Cradle to gate Publication: LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund T., Tillman A-M.; Report 1997:2; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	NTM
Method	Inventory
Literature Reference	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden
Notes	The data type unspecified implies that one do not know what the data is based on. Inventory of the production of ready mixed concrete has been performed at two plants in Göteborg owned by Färdig betong AB.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Additives	0			g	Technosphere	
	Input	Natural resource	Aggregates	786			g	Technosphere	
	Input	Natural resource	Cement	149			g	Technosphere	
	Input	Natural resource	Electricity	0.015			MJ	Technosphere	
	Input	Natural resource	Oil (eo1)	0.017			MJ	Technosphere	
	Input	Natural resource	Water	79.7			g	Technosphere	
Notes: The density of K30 is calculated to 2 366 ton/m3.	Output	Product	K40-ready mixed concrete	1			kg	Technosphere	
	Output	Residue	Industrial waste	15			g	Technosphere	

About Inventory

Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden -- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology --
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural concrete and steel frames in buildings during the whole life-cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of ready mixed concrete production K40.
Commissioner	- Finncement and Trätek (The Swedish Institute for Wood Technology Research) Box 5609 S-114 86 Stockholm Sweden.
Practitioner	Björklund T., Jönsson Å., Tillman A-M - Technical Environmental Planning, CTH Sven Hultins Gata 8 412 96 Göteborg Sweden .
Reviewer	
Applicability	To calculate the total environmental load, including the cement production, you can use the data in this Database at: Name: Production of cement Category: Cradle to gate Publication: LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund T., Tillman A-M.; Report 1997:2; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden The function of the technical system is not sufficently described. Contact Färdig betong AB Box 5162 402 26 Göteborg Sweden Phone +46 -31 7081500 to get the necessary details.
About Data	Aggregates It has to be noted that aggregates are considered to a nearly unlimited resource but in some parts of Sweden natural aggregates are very scarce. Substitutes are made from crushed blocks of stone to some greater energy expense compared to that of natural aggregates. In the study, all aggregates are regarded as natural aggregates. No calculation of energy use at the aggregate pit has been done. Additives Quantities of the admixtures are unknown, therefore, they are not taken into account. Water Water is taken from the community water system. It is in the study not regarded as a resource and is consequently not invented up-streams the flow. The density of K30 is calculated to 2 366 ton/m3. Waste Waste concrete from return deliveries and concrete from cleaning of the concrete mixer is reported to be 1.5 percent of the annual production. Transports not considered in this set of data: The cement is transported by truck about 160 km from Cementa's plant in Skövde to storages in Vallhamn and Varberg. The aggregates are delivered from Östad and Sjögärde, about 40 km by truck. The average distance to the customer is estimated to 30 km and the K30 is transported by truck.
Notes	

SPINE LCI dataset: Korea, electricity generation mix 1998

Administrative

Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System

Name	Korea, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Korea
Sector	Energyware
Owner	Korea
Technical system description	The generation of electricity with different power generating systems in Korea during the year 1998.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	NTM
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	14322			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	2			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	26302			GWh	Technosphere	

Represents: Solar	Input	Refined resource	Electricity	41			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	4187			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	4571			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	89689			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	96214			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	235328			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. --- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden ---
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998

	OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Landfill disposal

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	

Technical System	
Name	Landfill disposal
Functional Unit	1 kg
Functional Unit Explanation	1 kg waste disposed at lanfill.
Process Type	Gate to grave
Site	Sweden
Sector	Waste treatment
Owner	Sweden
Technical system description	Landfill disposal of waste consisting of: 14,8% Household waste 62,2% Industrial waste, incl. building and demolition waste 11,9% Ashes and slag 9,62% Sludge (20% solid matter) 1,48% Hazardous waste

System Boundaries	
Nature Boundary	Only the energy consumption and the waste dumped are accounted for. No emissions from the diesel combustion and the electricity used in the system are not accounted for. Also the emission caused by the degradation of organic matter is not accounted for in the data set.
Time Boundary	
Geographical Boundary	
Other Boundaries	The diesel used is accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991
Data Type	Unspecified
Represents	NTM
Method	The data are based on the information found in Tillman, A-M., H Baumann, E. Eriksson, and T. Ryden, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Notes	Emission factors for the electricity consumption should be added.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Emission factirs should be added for the combustion of diesel.	Input	Refined resource	Diesel	0.035			MJ	Technosphere	
Notes: Emission factors for the electricity consumption are not accounted for.	Input	Refined resource	Electricity	0.0007			MJ	Technosphere	
Notes: The waste that is disposed of consist of : 14,8% Household waste 62,2% Industrial waste, incl. building and demolition waste 11,9% Ashes and slag 9,62% Sludge (20% solid matter) 1,48% Hazardous waste	Input	Refined resource	Waste	1			kg	Technosphere	
	Output	Residue	Waste	1			kg	Technosphere	

About Inventory

Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Detailed Purpose	
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	Emission factors for the diesel combustion and the electricity used in the system are not accounted for. Also the emission caused by the degradation of organic matter is not accounted for in the data set. The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this one gets an unreliable result. The data are based on old sources (Swedish waste disposal 1990, RVF) and should therefore not be regarded as information describing the current situation.
About Data	
Notes	

SPINE LCI dataset: Landfilling of solid municipal waste

Administrative	
Finished	Y
Date Completed	2002-08-14
Copyright	McDougall F. et al, Integrated Solid Waste Management
Availability	Public

Technical System	
Name	Landfilling of solid municipal waste
Functional Unit	1 tonne of waste landfilled
Functional Unit Explanation	1 tonne of waste landfilled is waste from waste collection and sorting stations, biological treatment and thermal treatment plants.
Process Type	Gate to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Landfill is a waste treatment process with its own inputs and outputs, rather than simply a sink for the final disposal of solid waste. The environmental burdens of landfilling waste will depend both on the landfill design and method of operation, and the nature of the waste deposited. Included in the landfill system boundary are landfill, landfill gas collection, landfill gas combustion, hazardous landfill and leachate treatment. There are four main waste streams from municipal solid waste management systems that are landfilled. Inputs are: Restwaste (can be total Municipal solid waste), Sorting residue, Biological treatment residue and Thermal treatment residues (ash, filter dust and other residues from gas cleaning). Input streams can be divided into two groups; non-hazardous and hazardous. The inputs to the landfill system occur over a limited time period, i.e. the working life of the site. The outputs from the system occur over a much longer time span, which may involve at least tens and maybe hundreds of years. Outputs are: -- Landfill gas from biodegradable fraction in Municipal solid waste and biologically treated material (it is assumed for the purpose of this model that no landfilled gas is produced from ash) -- Leachate which result in solid waste residue from leachate treatment -- Inert solid waste from landfilled waste Outputs will depend on many factors e.g. the nature of the waste, method and level of compaction and the engineering of the landfill (how well the landfill is sealed). Landfill gas: Landfill gas is produced by an anaerobic decomposition of biodegradable organic material. The composition of the gas released will vary through the different phases of the active life of a landfill site. The composition of landfill gas is similar to that of biogas, and the heat content is similar. A typical composition of landfill gas also used in this documentation is given below (% by volume)(WMI, 1994): Methane, 52.8% Carbon dioxide, 44.1% Oxygen, 0.5% Nitrogen, 2% If no collection system exists for gas control or energy recovery, all of the landfill gas eventually leak out of the site and enter the atmosphere. Where gas collection occurs like in this model, around 40% will typically be recovered, whilst the remaining 60% still enters the atmosphere. (McDougall, 2001) Leachate: Any leachate treatment residues will be added to the total amount of final solid waste (Residual waste). The amount of leachate produced depends on many factors, for example the amount of rainfall on a landfill site. Leachate consists of organic C, N, F, P, S, Cl and heavy metals such as Cd, Cu, Hg, Pb and Zn. Composition of leachate varies with the stage

	of decomposition of the waste (e.g. pH, concentration of BOD, COD etc) Energy: The landfill process will consume energy both in the form of vehicle fuel and electricity. For all waste types landfilled, fuel and electricity will be consumed in the operation of the site itself. Data suggest that the fuel consumption for the landfilling process is around 0.6 litres of diesel per cubic metre of void space filled.(Biffa Waste Service, 1994) Energy recovery involves burning of landfill gas in a gas engine to generate electricity. Electrical recovery of 1.5 kWh/Nm3 of landfill gas collected gives 525 kWh per tonne waste landfilled, with an assumed conversion efficiency of 30% (ETSU, 1995). References: Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 ETSU, Energy From Landfill Gas, Appley Bridge Extended Renewable Energy Case Study, ETSU, New and Renewable Energies Bureau, Harwell, Oxfordshire, UK, 1995 Biffa Waste Service, communication, 1994

System Boundaries

Nature Boundary	A landfill site consumes land and the final solid waste fills up a volume, how much is not presented in this documetation due to lack of data. Emissions to air from landfill gas, are only represented of Methane, Carbon dioxide, Oxygen and Nitrogen (they are the main components in landfill gas) Methane has been reported to be responsible for about 20% (Lashof and Ahuja, 1990) of recent increase in global warming and landfills are thought to be the major source of methane. Emissions from generation of electricity from landfill gas within the system are not included due to lack of data. Emissions to water from different materials in the waste and emissions from leachate are not included in the system due to lack of data. Reference: Lashof and Ahuja,Relative contribution to greenhouse gas emissions to global warming, Nature, 344, April, 1990
Time Boundary	The inputs to the landfill system occur over a limited time period, i.e. the working life of the site, about 30 years.(McDougall, IWM, 2001) Data was collected during 1992-2001
Geographical Boundary	This activity represents a landfill site in a European country.
Other Boundaries	There are no data presented on electricity used in the landfill activity. Combustion of landfill gas is included in the system but data on emissions during power generation could not be found. All leachate produced is collected as residual waste. Leachate collection and treatment will consume energy, but that is not included due to lack of suitable data.
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1992-2001
Data Type	Unspecified
Represents	NTM
Method	LCI data are taken from the literature references McDougall (2001), WMI (1994) and Perry and Green (1997).
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Emission factors for the electricity consumption should be added.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*

Method: See description of functional unit.	Input	Refined resource	Waste to landfill	1			tonne	Technosphere	
Data type: Unspecified Method: Fuel consumption of 0.6 litre per cubic meter of void space filled in a landfill is an average number given by Biffa Waste Sevice 1994 through communication. Literature: Biffa Waste Service, 1994	Input	Refined resources	Diesel fuel	0.6			l	Technosphere	
Method: The composition of landfill gas usually is 44.1% CO2, 52.8% CH4, 0.5 % O2 and 2% N2 (% by volume)(WMI, 1994) 60% of landfill gas enters the atmosphere since 40% of gas is used for energy recovering. 60% of landfill gas (350Nm3/tonne waste) is 210 Nm3/tonne. Density of CO2 (0* Celcius, 100 kPa)=1.95 kg/m3 Literature: Waste Management International, Landfill Gas Data, Waste Management International, London, 1994	Output	Emission	CO2	180.59			kg	Air	
Method: The composition of landfill gas usually is 44.1% CO2, 52.8% CH4, 0.5 % O2 and 2% N2 (% by volume)(WMI, 1994) 60% of landfill gas enters the atmosphere since 40% of gas is used for energy recovering. 60% of landfill gas (350Nm3/tonne waste) is 210 Nm3/tonne. Density of CH4 (0* Celcius, 100 kPa)=0.71 kg/m3 Literature: Waste Management International, Landfill Gas Data, Waste Management International, London, 1994	Output	Emission	Methane	78.72			kg	Air	
Method: The composition of landfill gas usually is 44.1% CO2, 52.8% CH4, 0.5 % O2 and 2% N2 (% by volume)(WMI, 1994) 60% of landfill gas enters the atmosphere since 40% of gas is used for energy recovering.60% of landfill gas (350Nm3/tonne waste) is 210 Nm3/tonne. Density of N2 (0* Celcius, 100 kPa)=1.95 kg/m3 Literature: Waste Management International, Landfill Gas Data, Waste Management International, London, 1994	Output	Emission	N2	5.17			kg	Air	
Method: The composition of landfill gas usually is 44.1% CO2, 52.8% CH4, 0.5 % O2 and 2% N2 (% by volume)(WMI, 1994) 60% of landfill gas enters the atmosphere since 40% of gas is used for energy recovering.60% of landfill gas (350Nm3/tonne waste) is 210 Nm3/tonne. Density of O2 (0* Celcius, 100 kPa)=1.41 kg/m3 Literature: Waste Management International, Landfill Gas Data, Waste Management International, London, 1994	Output	Emission	O2	1.48			kg	Air	
Method: Landfill gas (52.8% CH4, 44.1% CO2, 0.5 O2, 2% N2) has an energy content of about 18 MJ/Nm3, with a calorific value of 37.75 MJ/Nm3 for methane. (McDougall, 2001) Landfill gas produced is 350 Nm3/tonne input waste (250 Nm3/tonne from biodegradable fractions in Municipal solid waste + 100 Nm3/tonne from biol.treatment products). It is assumed by McDougall, 2001 that 140 Nm3 is collected. Assume 60% energy recovery from gas and 30% efficiency of electricity generation gives 1.5 kWh/Nm3 of landfilled gas collected. 1.5*140= 210 kWh (McDougall, 2001)(Perry and Green,1997) Literature: Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997. Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001	Output	Product	Electricity	210			kWh	Technosphere	

Method: An estimation that around 13 % of the rainfall on a landfill site emerges as leachate, has been made. For sites in Germany with an average annual rainfall of 750 mm, this would produce around 100 litres of leachate per square metre of landfill site, per year. With a 20-metre dept of waste and density of 1 tonne/m3 gives a leachate production of 5 litres per tonne landfilled waste per year. If the active period for leachate production is around 30 years, the total amount would be 150 litres per tonne waste. (McDougall, IWM, 2001) 0.015 tonne solid waste from leachate treatment/m3 of leachate treated and 150 litre (0.15m3)/tonne waste input, result in a residual waste of 2.25 kg which were added to the inert solid waste landfilled. (McDougall, IWM, 2001) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Notes: Density of Residual waste was estimated to be 1.032 ton/m3 (McDougall, 2001) giving a volume of 971.2 m3 of residual waste.	Output	Product	Residual waste	1002.25			tonne	Ground	

About Inventory

Publication	McDougall F. et al, Integrated Solid Waste Management - A Life Cycle Inventory, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Data documented by: Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Documentation reviewed by: Ann-Christin Pålsson, Industrial Environmental Informatics, Chalmers University of Technology Published in SPINE@CPM: 14 August 2002
Intended User	The original study this d
General Purpose	Data about waste management systems are insufficient and more data are required by the industry.
Detailed Purpose	This documentation is based on a study about Integrated Solid Waste Management performed by Forbes McDougall et al at Procter& Gamble Technical Centres, 2001. The aims of that study was to introduce a LCI model for Integrated Waste Mangement and to provide data that support the concept of Integrated Waste Management as a sustainable method of managing solid waste. The purpose of the documentation of this system has been to make data for waste management available in this format for the industry.
Commissioner	
Practitioner	
Reviewer	
Applicability	The environmental burdens of landfilling waste will depend on the landfill design and method of operation, and the nature of the waste deposited. There are not much data available for individual material fractions in the inputs and outputs and the ones available generally refer to the landfilling of mixed waste streams, such as Municipal solid waste. It is difficult to provide typical figures for the generation of leachate and landfill gas from landfilled wastes. For leachate both the amount and composition of leachate will depend on many factors, including the nature of the waste, method and level of compaction, the engineering design of the landfill (e.g. how well the landfill is sealed) and the annual rainfall of the region. German scientists have estimated that around 13 % of the rainfall on a landfill site emerges as leachate. For sites in Germany with an average annual rainfall of 750mm, this would produce around 100 litres of leachate per square metre of landfill site, per year. With a 20-metre dept of waste, density 1 tonne/m3 gives a leachate production of 5 litres per tonne landfilled waste per year. If the active period for leachate production is around 30 years, the total amount would be 150 litres per tonne waste. Composition of leachate varies with the stage of decomposition of the waste (e.g. pH, concentration of BOD, COD etc) Outputs will depend on many factors e.g. the nature of the waste, method and level of compaction and the engineering of the landfill (how well the landfill is sealed). The landfill process will consume energy both in the form of vehicle fuel and electricity. For household waste that is landfilled directly, where the distance from the collection area to

	the landfill site is large, a transfer station may be used to bulk up the waste for more efficient transport by larger truck or rail. There are no data available on the energy consumption of transfer stations, therefore they are not includedin this activity, but generic fuel consumption data for road transport can be used. For all waste types landfilled, fuel and electricity will also be consumed in the operation of the site itself. Data suggest that the fuel consumption for the landfilling process is around 0.6 litres of diesel per cubic metre of void space filled.(Mc Dougall, Integrated Waste Management, 2001) Landfill gas not only consists of Methane, Carbon dioxide, Oxygen and Nitrogen but also of smaller amounts of Ethane, Hydrogen sulfide, propane, Toluene, xyelne etc. Methane has been reported to be responsible for about 20% of recent increase in global warming and landfills are thought to be the major source of methane.(Lashof and Ahuja, Relative contribution to greenhouse gas emissions to global warming, Nature, 344, April, 1990)
About Data	Data is based on a study performed by Procter & Gambler about Integrated Waste Management (McDougall F. et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001). Data are generally averages, giving an approximate measure of the environment burdens associated with the system. The descriptions of the activity is how it was understood by the person who made the documentation.
Notes	For further information about solid waste managment see: Flemström K., Brief overview of solid waste management, IMI-internal report. The report may be downloaded from: http://www.imi.chalmers.se

SPINE LCI dataset: Laying of linoleum-floor

Administrative	
Finished	Y
Date Completed	1994
Copyright	
Availability	Public

Technical System	
Name	Laying of linoleum-floor
Functional Unit	1 m3
Functional Unit Explanation	linoleu covering 1 m3
Process Type	Gate to gate
Site	
Sector	Consumer goods
Owner	
Technical system description	Laying of linoleum-floor.

System Boundaries	
Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	The waste and the linoleum-floor used are the only parameters that are accounted for.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	Unspecified, expert outspoke
Represents	NTM
Method	The data has been constructed based on the information that 10% of the material is wasted when the floor is being layed. This information comes from a floor-layer, who is not named.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Emission factors for the electricity consumption should be added.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Linoleum-floor	1.01			m2	Technosphere	
Notes: The floor that has been layed and is used for approximatly 25 years.	Output	Product	Linoleum-floor	1			m2	Technosphere	
Notes: Spill material	Output	Residue	Linoleum-floor	0.01			m2	Other	

About Inventory	
Publication	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994
Intended User	A Life Cycle Assessment practi
General Purpose	Exercise material in LCA course given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Detailed Purpose	
Commissioner	
Practitioner	Jönsson Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden.
Reviewer	
Applicability	
About Data	
Notes	

SPINE LCI dataset: Light truck, distribution, Euro 0

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Light truck, distribution, Euro 0

Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. (NOTE! DIFFERS FROM OTHER DISTRIBUTION VEHICLES WHICH ARE CALCULATED FOR A UTILISATION FACTOR OF 50%. THIS WILL BE CORRECTET IN THE NEXT UPDATE OF NTM) An utilisation level of 50 % is considered to be representative for Swedish domestic distribution traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of diesel driven light truck for distribution, approximately 9 m long with a curb weight of 14 tons and a maximum load of 8.5 tons. The vehicle is mainly used for local distribution, mainly in city traffic. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 3 l/10 km, medium 2.75 l/10 km, low 2.5 l/10 km. Engine type: Euro 0 (manufactured before 1992). Utilisation level: 70% by weight. (NOTE! DIFFERS FROM OTHER DISTRIBUTION VEHICLES WHICH ARE CALCULATED FOR A UTILISATION FACTOR OF 50%. THIS WILL BE CORRECTET IN THE NEXT UPDATE OF NTMS' HOMEPAGE)

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1987 - 1992
Geographical Boundary	Data is based on Swedish conditions.
Other Boundaries	The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. Empty trips are not included. *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying

	weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behaviour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.45	0.41	0.49	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.17	0.16	0.19	g	Air	Sweden
	Output	Emission	CO2	120	109	131	g	Air	Sweden
	Output	Emission	HC	0.10	0.088	0.11	g	Air	Sweden
	Output	Emission	NOx	2.0	1.8	2.2	g	Air	Sweden
	Output	Emission	Particles	0.046	0.042	0.050	g	Air	Sweden
	Output	Emission	SO2	1.5E-04	1.4E-04	1.6E-04	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the

	technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Björkman, Mikael - BTL 412 97 Göteborg .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used in terminal based transport systems in Sweden:*** *--Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):

	-excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The emission data of medium-sized and light trucks have been collected from certification values of new engines, driven according to fix driving cycles, e.g. ECR-49 (IVL and Mercedes).
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Light truck, distribution, Euro 1

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Light truck, distribution, Euro 1
Functional Unit	1 tonkm, 50 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 %. An utilisation level of 50 % is considered to be representative for Swedish domestic distribution traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden

Sector	Land transport
Owner	Sweden
Technical system description	Operation of light truck for distribution, approximately 9 m long with a curb weight of 14 tons and a maximum load of 8.5 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 3 l/10 km, medium 2.75 l/10 km, low 2.5 l/10 km. Engine type: Euro 1 (1993-1995). Utilisation level: 50% by weight.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1991 - 1995
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. Empty trips are not included. *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM

Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.63	0.57	0.69	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.22	0.20	0.24	g	Air	Sweden
	Output	Emission	CO2	168	153	184	g	Air	Sweden
	Output	Emission	HC	0.12	0.11	0.13	g	Air	Sweden
	Output	Emission	NOx	1.7	1.6	1.9	g	Air	Sweden
	Output	Emission	Particles	0.032	0.029	0.035	g	Air	Sweden
	Output	Emission	SO2	2.1E-04	1.9E-04	2.3E-04	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation

Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used in terminal based transport systems in Sweden:*** *--Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport.

	There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The emission data of medium-sized and light trucks have been collected from certification values of new engines, driven according to fix driving cycles, e.g. ECR-49 (IVL and Mercedes).
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Light truck, distribution, Euro 2

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Light truck, distribution, Euro 2

Functional Unit	1 tonkm, 50 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 %. An utilisation level of 50 % is considered to be representative for Swedish domestic distribution traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of light truck for distribution, approximately 9 m long with a curb weight of 14 tons and a maximum load of 8.5 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 3 l/10 km, medium 2.75 l/10 km, low 2.5 l/10 km. Engine type: Euro 2 (1993- 1999). Utilisation level: 50% by weight.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1993 - 1999
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. Empty trips are not included. *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values*

	have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.63	0.57	0.69	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.16	0.15	0.18	g	Air	Sweden
	Output	Emission	CO2	168	153	184	g	Air	Sweden
	Output	Emission	HC	0.084	0.076	0.092	g	Air	Sweden
	Output	Emission	NOx	1.5	1.4	1.6	g	Air	Sweden
	Output	Emission	Particles	0.023	0.021	0.025	g	Air	Sweden
	Output	Emission	SO2	2.1E-04	1.9E-04	2.3E-04	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.

Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used in terminal based transport systems in Sweden:*** *--Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %.

	Bulky goods The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The emission data of medium-sized and light trucks have been collected from certification values of new engines, driven according to fix driving cycles, e.g. ECR-49 (IVL and Mercedes).
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Light truck, distribution, made before 1990

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Light truck, distribution, made before 1990
Functional Unit	1 tonkm, 50 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 %. An utilisation level of 50 % is considered to be representative for Swedish domestic distribution traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden

Technical system description	Operation of light truck for distribution, approximately 9 m long with a curb weight of 14 tons and a maximum load of 8.5 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 3 l/10 km, medium 2.75 l/10 km, low 2.5 l/10 km. Engine type: made before 1990. Utilisation level: 50% by weight.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced before 1990
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. Empty trips are not included. *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*

Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.63	0.57	0.69	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.52	0.47	0.56	g	Air	Sweden
	Output	Emission	CO2	168	153	184	g	Air	Sweden
	Output	Emission	HC	0.39	0.35	0.42	g	Air	Sweden
	Output	Emission	NOx	3.4	3.1	3.7	g	Air	Sweden
	Output	Emission	Particles	0.19	0.18	0.21	g	Air	Sweden
	Output	Emission	SO2	2.1E-04	1.9E-04	2.3E-04	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in

a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred.

The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used.

The age categories of the vehicles compiled in the work are:
Older than 1990,
Euro 0: Introduced 1987, law from 1990
Euro 1: Introduced 1991, law from 1993
Euro 2: Introduced 1993, law from 1996
However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle.

Handling of goods
The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials)
Terminal based road transports generally consists of 1-3 parts:
1. Collection of the goods to terminal
2. Long-distance transport between terminals
3. Distribution of the goods from terminal
The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation.

--Wholesale goods (>1000 kg) are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport.
--General goods (100-1000 kg) are generally handled via terminal. The goods may be both weight and volume limited
--Parcel goods (<100 kg) are normally handled in small vehicles

The following vehicles and equipages are used in terminal based transport systems in Sweden:
--Parcel truck/van, max 3,5 tonnes is mainly used for transportation of parcels.
--Light truck, max 8 tonnes is used for local distribution, mainly in city traffic.
--Truck, max 18 tonnes is used for district distribution and local distribution in city traffic.
--Truck, max 24 tonnes is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--Heavy truck with trailer, max 60 tonnes is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--Truck with semi-trailer, max 42 tonnes is used for international long-distance traffic.

Utilisation level
The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the

	data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The emission data of medium-sized and light trucks have been collected from certification values of new engines, driven according to fix driving cycles, e.g. ECR-49 (IVL and Mercedes).
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Light truck, max 3,5 tonnes, diesel driven

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Light truck, max 3,5 tonnes, diesel driven
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven light truck. The vehicle is mainly used for transportation of parcels. Maximum gross weight: 3,5 tonnes. Kerb weight: 2,1 tonnes. Available loading capacity with regard to weight: 1,4 tonnes. Length: 5,5 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents vehicles in use in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors, together with assumptions on the fuel consumption, type of fuel used and utilisation level. See specific QMetaData for each flow. Method description for NOx, HC, particles and CO can be found under NOx The quantity value for the energy use refer to average fuel consumption, the maximum and minimum value refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. **The following data was used in the calculations:** *Assumptions given by the Swedish Road Haulage Association:* Average fuel consumption: 0,18 l/km. Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data was given by the Swedish Petroleum Institute.	Input	Refined resource	Diesel environmental class 1	6.46			MJ	Technosphere	

	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.51			g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. **The following data was used in the calculations:** *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l CO_2 emission: 73 g/MJ fuel Sulphur content: 10 ppm The data was supplied by the Swedish Petroleum Institute. *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,18 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight.	Output	Emission	CO_2	472			g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.153			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors (g/vehicle km). The emission factors were compiled by IVL (Swedish Research Institute). **The following data was used in the calculations:** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,18 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *The emission factors were:* -NOx 0,5 g/vehicle km -HC 0,15 g/vehicle km -CO 0,5 g/vehicle km -Particles 0,1 g/vehicle km	Output	Emission	NOx	0.51			g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.102			g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel **The following data was used in the calculations:** *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,18 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight.	Output	Emission	SO_2	0.003			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport

	companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Larson, Lars-Gunnar - FFA (Flygtekniska försöksanstalten), Box 11021 S-161 11 Bromma Sweden.
Reviewer	
Applicability	!The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute,

	the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	The data for emissions is based on emission factors. The origin of the emission factors is not specified. This means that several parameters that influence the energy use and emissions in regular traffic are probably not considered, e.g. climate, topography, driving technique, maintenance etc. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Light truck, max 3,5 tonnes, gasoline driven

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Light truck, max 3,5 tonnes, gasoline driven
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden

Technical system description	Operation of a gasoline driven light truck. The vehicle is mainly used for transportation of parcels. Maximum gross weight: 3,5 tonnes. Kerb weight: 2,1 tonnes. Available loading capacity with regard to weight: 1,4 tonnes. Length: 5,5 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for gasoline engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents vehicles in use in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors, together with assumptions on the fuel consumption, type of fuel used and utilisation level. See specific QMetaData for each flow. Method description for NOx, HC, particles and CO can be found under NOx The quantity value for the energy use refer to average fuel consumption, the maximum and minimum value refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The gasoline consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. **The following data was used in the calculations:** *Assumptions given by the Swedish Road Haulage Association:* Average fuel consumption:	Input	Refined resource	Gasoline	9.05			MJ	Technosphere	

0,28 l/km. Utilisation level: 70 %, of the available loading capacity with regard to weight.									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	1.531			g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the gasoline. **The following data was used in the calculations:** *Data for the fuel, gasoline:* Thermal value: 41,86 MJ/kg Density: 0,75 kg/l CO2 emission: 74 g/MJ fuel Sulphur content: 150 ppm The data was supplied by the Swedish Petroleum Institute. *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,28 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. See QMetaData for the Gasoline flow for further information	Output	Emission	CO2	669			g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.204			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors (g/vehicle km). The emission factors were compiled by IVL (Swedish Environmental Institute) **The following data was used in the calculations:** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,18 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *The emission factors were:* NOx 0,1 g/vehicle km HC 0,2 g/vehicle km CO 1,5 g/vehicle km particles 0,005 g/vehicle km	Output	Emission	NOx	0.102			g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.005			g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the gasoline **The following data was used in the calculations:** *Data for the fuel, gasoline:* Thermal value: 41,86 MJ/kg Density: 0,75 kg/l Sulphur content: 150 ppm *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,28 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. See QMetaData for the gasoline flow for further information.	Output	Emission	SO2	0.065			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of

	organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	!The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport. The vehicle is also permitted in Finland.* *--Truck with semitrailer, max 42 tonnes is used for international long-distance traffic.* ***Utilisation level*** *The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low.* *The utilisation level includes both weight and volume limited goods, but not empty trips. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):* *-excavated materials and round timber - 50%* *-manufactured products (wholesale goods) - slightly more than 20%* *-provisions and animal forage - approx. 15%* *-mixed cargo (general goods) approx - 10 %.* ***Bulky goods*** *The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.*
About Data	The data for emissions is based on emission factors. The origin of the emission factors is not specified. This means that several parameters that influence the energy use and emissions in regular traffic are probably not considered, e.g. climate, topography, driving technique, maintenance etc. Since exhaust emissions depend on the engine speed and load conditions,

	the emissions in actual operation may vary substantially.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Light truck, max 8 tonnes, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Light truck, max 8 tonnes, future
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven light truck with engine representing best available technology (proposed Euro 3 environmental standard) with oxidation filter and catalytic control. The vehicle is mainly used for local distribution, mainly in city traffic. Maximum gross weight: 8 tonnes. Kerb weight: 5 tonnes. Available loading capacity with regard to weight: 3 tonnes. Length: 7 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents best available technology, not yet in regular use.

Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by a new test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level. See specific QMetaData for each flow.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	4.32			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.049			g	Air	

Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	315			g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.049			g	Air	
Date concieved: 1996-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors (g/kWh) obtained by a a new test cycle, on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The tests was perfomed by Motortestcenter. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) **The following data was used in the calculations:** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,27 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data were supplied by the Swedish Petroleum Institute *The emission factors were:* -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data can be found in Ahlvik. Literature: Ahlvik P., Almén J., Grägg K., Laveskog A. *Avgasemissioner med alternativa bränslen* Motortestcenter, februari 1996 (Published in SOU 1996:184 *Bilagor till betänkande av alternativbränsleutredningen*)	Output	Emission	NOx	2.5			g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.0098			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.0019			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 --- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM ---
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions. The data represents best available technology, not yet in use.
About Data	The data is based on tests on the engine performed in a laboratory according to a new test cycle (proposed for standardisation). This means that several parameters that influence the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Light truck, max 8 tonnes, manufactured after 1996 [Euro 2]

Administrative

Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System

Name	Light truck, max 8 tonnes, manufactured after 1996 [Euro 2]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven light truck with engine manufactured after 1996 (Euro 2 environmental standard). The vehicle is mainly used for local distribution, mainly in city traffic. Maximum gross weight: 8 tonnes. Kerb weight: 5 tonnes. Available loading capacity with regard to weight: 3 tonnes. Length: 7 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured after 1996
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO_2 and SO_2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation, the *maximum value* refer to an engine run 500 000 km. No minimum value was given.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	4.52	4.46	4.59	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.36		0.44	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further	Output	Emission	CO_2	330	325	335	g	Air	

information									
Method: See QMetaData for NOx.	Output	Emission	HC	0.21		0.22	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The following formula was used to calculate the emissions per tonkm: (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine*: -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data was supplied by Volvo Truck Corporation. *Maximum value i.e. engine run 500 000 km* The data was supplied by Volvo Truck Corporation and expressed as percentage degeneration in emissions in relation to the average engine. The degeneration factors are based on special degeneration factor tests for EPA/CARB on 12 litre engines. The tests were performed on four engines run 470 000 km. The degeneration factors are an average of the tests. -NOx 6,4 g/kWh - 1,5 % degeneration in relation to the average engine -HC 0,42 g/kWh - 4 % degeneration in relation to the average engine -CO 0,8 g/kWh - 20 % degeneration in relation to the average engine -Particles 0,11 g/kWh - 2 % degeneration in relation to the average engine -Degree of efficiency on the engine: 41 % (assumption) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.	Output	Emission	NOx	3.2		3.3	g	Air	
Method: See QMetaData for NOx.	Output	Emission	Particles	0.057		0.059	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage*	Output	Emission	SO2	0.00208		0.00215	g	Air	

Association: -Average fuel consumption 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information									

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use. The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal

	The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle

	that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Light truck, max 8 tonnes, manufactured before 1992 [Euro 0]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Light truck, max 8 tonnes, manufactured before 1992 [Euro 0]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven light truck with engine manufactured before 1992 (Euro 0 environmental standard). The vehicle is mainly used for local distribution, mainly in city traffic. Maximum gross weight: 8 tonnes. Kerb weight: 5 tonnes. Available loading capacity with regard to weight: 3 tonnes. Length: 7 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured before 1992
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to voluntary European emission regulations for diesel engines before 1992.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,27 l/km.	Input	Refined resource	Diesel environmental class 1	4.52	4.49	4.58	MJ	Technosphere	

-Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.7		5.9	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	330	328	334	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.73		1.24	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to voluntary European emission regulations for diesel engines before 1992. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/ (loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,27 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:*: -NOx 11 g/kWh -HC 1,5 g/kWh -CO 1,5 g/kWh -Particles 0,4 g/kWh (estimated) -Degree of efficiency on the engine:39 % (assumed) The data was supplied by the Volvo Truck Corporation. *Maximum value, i.e.*	Output	Emission	NOx	5.4	4.4	6.9	g	Air	

voluntary European emission regulations: -NOx 14 g/kWh -HC 2,5 g/kWh -CO 12 g/kWh -Particles - g/kWh (not given) -Degree of efficiency on the engine: 39 %. No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx	Output	Emission	Particles	0.2			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO_2	0.00208	0.00205	0.00213	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use

	today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions.

	Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Light truck, max 8 tonnes, manufactured between 1992 and 1995 [Euro1]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Light truck, max 8 tonnes, manufactured between 1992 and 1995 [Euro1]
Functional Unit	1 tonkm, 70 %

Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven light truck with engine manufactured between 1992 and 1995 (Euro 1 environmental standard). The vehicle is mainly used for local distribution, mainly in city traffic. Maximum gross weight: 8 tonnes. Kerb weight: 5 tonnes. Available loading capacity with regard to weight: 3 tonnes. Length: 7 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured between 1992 and 1995
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to the emission regulations for diesel engines according to the emission standard Euro I.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Waste Management International, Landfill Gas Data, Waste Management International, London, 1994 Perry and Green, The Chemical Engineer'sHandbook, McGraw Hill, 1997.

Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo				tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	4.52	4.47	4.56	MJ	Technosphere	
	Output	Cargo	Cargo				tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.5		2.3	g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	330	327	333	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.25		0.56	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to emission regulations for diesel engines according to the emission standard Euro I. No minimum value was	Output	Emission	NOx	3.8		4.1	g	Air	

given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,27 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:* -NOx 7,6 g/kWh -HC 0,5 g/kWh -CO 1,0 g/kWh -Particles 0,2 g/kWh -Degree of efficiency on the engine: 40 % (assumed) The data was supplied by the Volvo Truck Corporation *Maximum value, i.e. emission standard Euro I for diesel engines:* -NOx 8 g/kWh -HC 1,1 g/kWh -CO 4,5 g/kWh -Particles 0,36 g/kWh -Degree of efficiency on the engine: 40 % (assumed) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx	Output	Emission	Particles	0.095			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,27 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00208	0.00204	0.00212	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology

	Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** *--Truck max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*.

	During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Lignite electricity energy system, EPD-version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Lignite electricity energy system, EPD-version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures are based on data from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996 and adapted to the demands of the EPD-guidelines (Environmental Product Declaration guidelines in Sweden). -- Brief description -- The main phases inventoried in ETH's life cycle study of electricity generation with lignite are: mining, transports and power plant operation. Data has been aquired from literature and figures concerning consumption of energyware and materials, use of land and water, emissions to air (also radioactive) and water and wastes have been picked out from or calculated based on literature for all phases of the life cycle. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle. -- Detailed description -- Mining The prospecting of lignite implies test drillings etc but is not inventoried separatly since only a few millimeters of drilling per tonne lignite is needed. Mining depths are mostly less than 200 m but may reach 600 m. Noise (not quantified in this study), radioactive radon, methane and particles are process specific emissions to air and subsoilwater to water. Open pit mining (94% of used lignite in UCPTE) is studied. For the UCPTE average underground mining has been estimated and added. Two to six times the amount of lignite must be dug out, i.e. large strong mashines are needed. Mainly electrified mobile machines are used, often supplied by a nearby lignite power plant (but UCPTE electricity generation mix has been used in the calculations) but also diesel driven machines. Lower heating value of lignite used in UCPTE power plants has an average of 7,9 GJ/tonne lignite. The subsoil water level must be lowered below the seam. Construction and operation of mines have been inventoried. Demolition processes imply depositing of wood and concrete and metalscrap is assumed to be transported to recycling plants. Transports Extracted lignite is transported to nearby power plants on feeder bands, by lorry or train. No processing of lignite is needed. Power plant Construction and area use has been inventoried for two standard plants (100 and 500 MWe). The smaller standard plant is equiped with electrofilter and wet desulphuring with lime or limestone, the larger plant has a SCR de-NOx device as well. 70% of the UCPTE lignite power plants belong to the 500 MWe class. Combined heat and power is not studied,

	i.e. all generated electricity is supposed to come from lignite condensing plants (electricity from CHPs is less than 5% of UCPTE electricity generation). The plants are base load power plants with an average of 6000 h of operation per year. Furnace technology is conventional (i.e. no gasifyers or fluid beds). Average efficiencies of UCPTE power plants have been calculated (30.9%) based on national statistics. Incoming coal (average heating value 8 MJ/kg) is mixed, grinded and dried. Furnace temperatures of 1,300°C giving fly ashes or 1,600°C leading to ash melting are used. Concerning conventional emissions to air national statistics and bottom-up calculations based on existing UCPTE power plants have been used. Emissions of trace elements are estimated and other emissions are calculated based on literature data. Leaching of substances from deposited ashes is included. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries

Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH. Vattenfall's criterion in selecting and aggregating ETH's LCI-results for electricity generation in the UCPTE region has been to make the figures usable as general electricity LCI data in EPDs according to Miljöstyrningsrådets guidelines. Especially parameters (emissions) which have established impact indices - accepted by the EPD system - for one or several environmental impact categories, have been picked out and aggregated as far possible. But also metal and energyware resources have been included, as well as waste, in spite of all waste handling processes related to this dataset being included with respect to use of resources and emissions. The latter is an adaption to other LCI data for electricity generation where waste amounts are reported (since those flows have not been followed to the grave). Since ETH claimes that most of the figures regarding metal emissions have an undefined amount of datagaps all metal emissions are aggregated except for a few which are specified separatly since they are reported for most processes in the lifecycle. Metals are reported as elements although they often are part of compounds. Measuring methods often just give the amounts of the different elements found. All hydrocarbons to water are aggregated to one parameter as well as halogenated organics, since no indices exist (that are accepted by the EPD system so far) for characterisation of the individual substances.
Time Boundary	Most background data refer to the period 1990 to 1994. Concerning flue gas cleaning equipment data from 1995/96 has been used where possible. Figures regarding use of materials and mining and processing of coal are older which probably doesn´t affect the result much. Future emissions from deposits for filter ashes are included. Power plant operation is based on the year 1994. Electricity used during the lifecycle has been assumed to be a mix based on the average generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years). All processes, also those conducted in the past, have been assumed to use average technology of the early nineties. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Equipment in mines 30 years Power plant 30 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	Figures are based on average lignite power plants in Austria, Germany, Spain, Ex-Jugoslavia, France and Greece. Lignite mining has been studied in the UCPTE since less than 1% is imported. 67% of lignite used in UCPTE is mined in Germany. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE*

	electricity. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	Data concerning material and energyware use in the construction phase of the mine are rough estimates based on a few real mines. Process specific (i.e. not energyware related) emissions to air from mines have not been included except for radon, methane and particles. The flow of substances in subsoil water is not complete. Use and emissions of lubricating and hydraulic oil is not included. Losses of lignite in the mining area has not been accounted for. Losses of lignite during transport or reloading has not been accounted for. Accidents and filter failures are not considered in the power plant. Most data concerning the power plant are based on assumptions and estimates. Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. The ETH study comprises figures concerning use of land, usable content in water storages and amount of turbine water which have not been reported here. The two latter have been excluded due to lack of corresponding data in comparable studies. Use of land has been excluded here because of ETH's advanced approach. Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the indutrial revolution I Modified human impact larger than other species', low degree of culivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of intererst. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is different from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH specifies about 160 radioactive isotopes emitted to air and water. Radioactive emissions reported here are picked out in accordance with SETAC working group report on data quality and data availability (to be published in 2001). Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average electricity generation with lignite in the UCTPE countries.

Method	The data has been adapted from the Ökoinventare von Energiesystemen, ETH Zürich 1996 and is an aggregation of the LCI results for the module ''electricity of lignite power plant UCPTE'' (Strom ab Braunkohlekraftwerk UCPTE-Mix).
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Bauxite	7.99			kg	Ground	
	Input	Natural resource	Chromium in ore	0.731			kg	Ground	
	Input	Natural resource	Copper in ore	5.46			kg	Ground	
Notes: From drillhole	Input	Natural resource	Crude oil	478			kg	Ground	
Notes: Before processing	Input	Natural resource	Hard coal	1400			kg	Ground	
	Input	Natural resource	Iron in ore	319			kg	Ground	
	Input	Natural resource	Lead in ore	0.0394			kg	Ground	
Notes: Before extraction	Input	Natural resource	Lignite	414000			kg	Ground	
	Input	Natural resource	Limestone	1880			kg	Ground	
	Input	Natural resource	Manganese in ore	0.455			kg	Ground	
Notes: Summation of ''Erdoelgas'' (40,9 MJ/Nm3), ''Grubengas'' (35,9 MJ/kg) and ''Rohgas'' (35 MJ/Nm3). Expressed as Natural gas with lower heating value (35 MJ/Nm3). The heating values are acquired from table III 8.1 in the methodology chapter in the Ökoinventare von Energiesystemen, ETH, Zürich 1996	Input	Natural resource	Natural gas	392.3			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.299			kg	Ground	
	Input	Natural resource	Palladium in ore	9.53E-08			kg	Ground	
	Input	Natural resource	Platinum in ore	1.08E-07			kg	Ground	
	Input	Natural resource	Rhodium in ore	1.01E-07			kg	Ground	
	Input	Natural resource	Rock salt	36.2			kg	Ground	
	Input	Natural resource	Uranium in ore	0.0947			kg	Ground	
	Input	Natural resource	Water	1.35E+07			kg	Ground	
	Input	Natural resource	Wood	27.5			kg	Ground	
	Input	Natural resource	Zinc in ore	0.00163			kg	Ground	
Notes: Summation of Ag, Sn, Rh, Mo, Co.	Input	Refined resource	Metals	2.35E-03			kg	Technosphere	
	Output	Emission	1,2-Dichloroethane	2.13E-05			kg	Air	
	Output	Emission	Ag-110m	0.267			kBq	Water	
	Output	Emission	Ag-110m	3.92E-05			kBq	Air	
	Output	Emission	Am-241	0.0961			kBq	Water	
	Output	Emission	Am-241	7.29E-04			kBq	Air	

Notes: BOD5	Output	Emission	BOD	3.71E-02			kg	Water	
	Output	Emission	C-14	4.86			kBq	Water	
	Output	Emission	C-14	58.7			kBq	Air	
	Output	Emission	C-60	1.65E-03			kBq	Air	
	Output	Emission	Cd	2.74E-04			kg	Water	
	Output	Emission	Cd	7.75E-07			kg	Ground	
	Output	Emission	Cd	9.28E-03			kg	Air	
	Output	Emission	CFC-11	3.00E-05			kg	Air	
	Output	Emission	CFC-114	7.93E-04			kg	Air	
	Output	Emission	CFC-12	6.45E-06			kg	Air	
	Output	Emission	CFC-13	4.05E-06			kg	Air	
	Output	Emission	Cm alpha	0.127			kBq	Water	
	Output	Emission	Cm alpha	1.16E-03			kBq	Air	
	Output	Emission	Cm-244	3.49E-08			kBq	Air	
	Output	Emission	CN-	1.47E-03			kg	Water	
Notes: CN- is Cyanide ion	Output	Emission	CN-	9.42E-05			kg	Air	
	Output	Emission	CO	45.177			kg	Air	
	Output	Emission	CO2	370979			kg	Air	
	Output	Emission	Co-58	0.421			kBq	Water	
	Output	Emission	Co-58	1.11E-03			kBq	Air	
	Output	Emission	Co-60	21.238			kBq	Water	
	Output	Emission	COD	0.098			kg	Water	
	Output	Emission	Cr	1.69E-04			kg	Ground	
	Output	Emission	Cr	2.37E-02			kg	Water	
	Output	Emission	Cr	2.86E-02			kg	Air	
	Output	Emission	Cs-134	2.77E-02			kBq	Air	
	Output	Emission	Cs-134	4.9154			kBq	Water	
	Output	Emission	Cs-137	0.0535			kBq	Air	
	Output	Emission	Cs-137	45.225			kBq	Water	
	Output	Emission	Dichloromethane	1.80E-04			kg	Air	
Notes: 2,3,7,8-Tetrachlorodibenzo-p-Dioxin-equivalents	Output	Emission	Dioxin (TCDD)	17300			ng	Air	
	Output	Emission	Dissolved solids	0.9399			kg	Water	
	Output	Emission	H-1301	1.86E-04			kg	Air	
	Output	Emission	H2S	0.0224			kg	Air	
	Output	Emission	H-3	1.44E+05			kBq	Water	
	Output	Emission	H-3	605			kBq	Air	
Notes: Summation of AOX, 1,1,1-trichloroethane, chlorobenzene, dichloromonofluoromethane, ethylene dichloride, hexachlororethane, metylenchloride, tetrachloroethylene, trichloroethylene, trichloromethane.	Output	Emission	Halogenated organics	3.80E-04			kg	Water	
Notes: Summation of Cl-, F- and I-.	Output	Emission	Halogenids	3.75E+01			kg	Water	
Notes: Summation of I and Br.	Output	Emission	Halogens	1.24E+00			kg	Air	
	Output	Emission	HCFC-21	6.36E-04			kg	Air	
	Output	Emission	HCFC-22	7.06E-06			kg	Air	
	Output	Emission	HCl	136.019			kg	Air	
Notes: No available index. Same index as NMVOC.	Output	Emission	Hexachlorobenzene	4.27E-10			kg	Air	
	Output	Emission	Hexafluoroethane	8.69E-05			kg	Air	
	Output	Emission	HF	13.80369			kg	Air	
	Output	Emission	HFC-134a	4.21E-17			kg	Air	
	Output	Emission	Hg	1.94E-02			kg	Air	
	Output	Emission	Hg	1.96E-07			kg	Ground	
	Output	Emission	Hg	3.88E-05			kg	Water	
Notes: Summation of acenaphtene, acenaphtylene, alkane, alkene, aromats, benzene, butyl benzyl phtalat, bibutyl p-phtalat, dimethyl p-phtalat, ethylbenzen, volatile hydrocarbons, formaldehyd, glutaraldehyd, hydrocarbons, MTBE (Metyl Tertiary Butyl Eter),	Output	Emission	Hydrocarbons	4.60E-02			kg	Water	

phenol, styrol, toluol, triethylenglycol, xylol.									
	Output	Emission	I-129	0.208			kBq	Air	
	Output	Emission	I-129	13.9			kBq	Water	
	Output	Emission	I-131	0.00925			kBq	Water	
	Output	Emission	I-131	0.0233			kBq	Air	
	Output	Emission	I-133	0.00225			kBq	Water	
	Output	Emission	I-133	0.0129			kBq	Air	
	Output	Emission	K-40	0.349			kBq	Water	
	Output	Emission	K-40	6.27			kBq	Air	
	Output	Emission	Kr-85	3.59E+06			kBq	Air	
Notes: Summation of the ions of following metals: Ag, Al, Ar, Ba, Be, Cs, Ca, Fe, K, Co, Mg, Mn, Mo, Na, Ni, Ru, Sb, Se, Sn, Sr, Ti, W.	Output	Emission	Metal ions	6.93E+02			kg	Water	
Notes: Summation of Al, As, Ca, Co, Cu, Fe, Mn, Ni, Sn.	Output	Emission	Metals	2.38E-01			kg	Ground	
Notes: Summation of Al, As, Ba, Be, Ca, Co, Cu, Fe, K, La, Mg, Mn, Mo, Ni, Pt, Sb, Sc, Se, Sn, Sr, Th, Ti, Tl, U, Zr.	Output	Emission	Metals	3.55E+01			kg	Air	
	Output	Emission	Methane	31.49704			kg	Air	
	Output	Emission	Mn-54	3.2596			kBq	Water	
	Output	Emission	Mn-54	3.97E-05			kBq	Air	
	Output	Emission	N	3.97E-05			kg	Ground	
	Output	Emission	N total	0.09817			kg	Water	
	Output	Emission	N2O	1.84632			kg	Air	
	Output	Emission	NH3	1.800892			kg	Air	
Notes: Summation of acetaldehyd, acetylene, aceton, acrolein, aldehyd, alkane, alkene, aromats, benzaldehyd, benzene, butan, buten, acetic acid, etan, etanol, etene, ethylbenzene, ethylenoxide (C2H4O), formaldehyd, heptan, hexan, metanol, MTBE (Metyl Tertiary Butyl Eter), NMVOC, pentane, phenol, propan, propen, propion aldehyd, propionic acid, styrol, toluol, xylol.	Output	Emission	NMVOC	1.26E+01			kg	Air	
	Output	Emission	NO2-	3.71E-03			kg	Water	
	Output	Emission	NO3-	0.05258			kg	Water	
Notes: as NO2	Output	Emission	NOx	557.999			kg	Air	
	Output	Emission	Np-237	0.00613			kBq	Water	
	Output	Emission	Oil	2.17E-02			kg	Ground	
	Output	Emission	Oil	4.74E-01			kg	Water	
	Output	Emission	P	0.0018			kg	Ground	
	Output	Emission	P total	6.34E-02			kg	Air	
	Output	Emission	PAH	3.56E-04			kg	Water	
Notes: Same index as NMVOC.	Output	Emission	PAH	3.58E-03			kg	Air	
	Output	Emission	Particles	257.6644			kg	Air	
	Output	Emission	Pb	1.51E-05			kg	Ground	
	Output	Emission	Pb	1.92E-02			kg	Water	
	Output	Emission	Pb	2.92E-02			kg	Air	
	Output	Emission	Pb-210	0.278			kBq	Water	
	Output	Emission	Pb-210	22.258			kBq	Air	
Notes: C6HCl5, no available index. Same index as NMVOC.	Output	Emission	Pentachlorobenzene	1.14E-09			kg	Air	
Notes: C6HCl5O, no available index. Same index as NMVOC.	Output	Emission	Pentachlorophenol	1.84E-10			kg	Air	
	Output	Emission	Po-210	0.278			kBq	Water	
	Output	Emission	Po-210	40.458			kBq	Air	
	Output	Emission	PO43-	1.38E-01			kg	Water	
	Output	Emission	Pu alpha	0.00231			kBq	Air	
	Output	Emission	Pu alpha	0.382			kBq	Water	
	Output	Emission	Pu-238	8.68E-08			kBq	Air	
	Output	Emission	Ra-226	1772.11			kBq	Water	
	Output	Emission	Ra-226	6.407			kBq	Air	

Notes: Long-term emissions of Rn-222	Output	Emission	Rn-222	5.15E+06			kBq	Air	
	Output	Emission	Rn-222	5.75E+04			kBq	Air	
	Output	Emission	Ru-106	0.231			kBq	Air	
	Output	Emission	Ru-106	23.1			kBq	Water	
	Output	Emission	S	0.0203			kg	Ground	
Notes: Includes Tot-S, S-, S in H2S, S in sulphate, S in sulphite	Output	Emission	S total	4.62E+02			kg	Water	
	Output	Emission	Sb-124	0.0689			kBq	Water	
	Output	Emission	Sb-124	1.07E-05			kBq	Air	
	Output	Emission	Sb-125	0.00401			kBq	Water	
	Output	Emission	Sb-125	1.38E-06			kBq	Air	
	Output	Emission	SO2	3623.53			kg	Air	
	Output	Emission	Sr-90	0.0382			kBq	Air	
	Output	Emission	Sr-90	4.63E+00			kBq	Water	
	Output	Emission	Suspended solids	1.929			kg	Water	
	Output	Emission	Tc-99	1.62E-06			kBq	Air	
	Output	Emission	Tc-99	2.43			kBq	Water	
	Output	Emission	Tetrachloromethane	3.48E-05			kg	Air	
	Output	Emission	Tetrafluoromethane	0.000782			kg	Air	
	Output	Emission	Th-230	0.258			kBq	Air	
	Output	Emission	Th-230	67.1			kBq	Water	
	Output	Emission	Th-232	0.0651			kBq	Water	
	Output	Emission	Th-232	1.63			kBq	Air	
Notes: Summation of dissolved organic carbon, fat acids as C, volatile organic compounds as C, TOC.	Output	Emission	Total organic carbon	1.32E+00			kg	Water	
	Output	Emission	Tributyl tin	7.65E-05			kg	Water	
	Output	Emission	Trichloromethane	5.62E-07			kg	Air	
	Output	Emission	U-234	0.278			kBq	Air	
	Output	Emission	U-234	0.573			kBq	Water	
	Output	Emission	U-235	0.0135			kBq	Air	
	Output	Emission	U-235	0.854			kBq	Water	
	Output	Emission	U-238	1.45			kBq	Water	
	Output	Emission	U-238	5.024			kBq	Air	
	Output	Emission	V	1.19E-02			kg	Water	
	Output	Emission	V	8.06E-02			kg	Air	
	Output	Emission	Vinyl chloride	3.47E-06			kg	Air	
	Output	Emission	Xe-133	2580			kBq	Air	
	Output	Emission	Zn	1.76E-01			kg	Air	
	Output	Emission	Zn	3.90E-02			kg	Water	
	Output	Emission	Zn	5.40E-04			kg	Ground	
	Output	Product	Electricity	1			TJ	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) and processing of hazardous waste is included.	Output	Residue	Hazardous waste	1.57E+01			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Highly radioactive waste	1.62E-05			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, no emissions from landfill assumed. Inert waste deposit is waste at landfill that are inert.	Output	Residue	Inert waste deposit	1.27E+03			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Low radioactive waste	1.97E-04			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Medium and low radioactive waste	1.98E-04			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from landfill. Reactive waste deposit is waste at landfill that is still reactive.	Output	Residue	Reactive waste deposit	4.70E+04			kg	Technosphere	

Notes: Internal flow! Infrastructure of spreading vehicles and emissions are included. Land farming is a treatment of organic sludge, the sludge is spread on a piece of land and left to degrade. Sometimes plants are grown on the land, but those plants are destroyed.	Output	Residue	Waste in land farming	3.56E+00			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from incineration plant.	Output	Residue	Waste to incineration	4.08E-01			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www.energieforschung.ch. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their life cycles. The results can be used in life cycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans. Vattenfalls purpose - as a commissioner of putting ETH:s data into Spine format with metadata - is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines. Data is supposed to be used together with IEA statistics about electricity generation mixes in the OECD countries/regions.
Detailed Purpose	ETH:s aim was to describe the average situation in the UCPTE concerning electricity generation with lignite. With the help of assumptions and simplifications following phases of the life cycle are described: mining (open pit), transports and power plant.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Data reported here is supposed to be representative for lignite based elctricity generation in the UCPTE countries in 1994. This set of data is aggregated and documented in accordance with the Swedish EPD-guidelines to be used in combination with IEA statistics concerning electricity generation mixes in OECD countries and regions together with other datasets - based on the ETH study - describing other power generation systems. The EPD-adapted power generation systems in Spine format are named as follows: Fuel gas electricity energy system, EPD-version Biofuel electricity energy system, EPD-version Hydro electricity energy system, EPD-version Lignite electricity energy system, EPD-version Nuclear electricity energy system, EPD-version Stone coal electricity energy system, EPD-version Wind electricity energy system, EPD-version IEA statistics for generation mixes 1998 exist in Spine format for the following 30 countries/regions: OECD total OECD North America OECD Pacific OECD Europe European Union Australia Austria Belgium Canada Czech Rpublic

	Denmark Finland France Germany Greece Hungary Iceland Ireland Italy Japan Korea Luxembourg Mexico Netherlands New Zealand Norway Poland Portugal Spain Sweden Switzerland Turkey United Kingdom United States
About Data	Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided). Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of ETH:s data and metadata has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of aggregation of figures and of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. The technical committee of the Swedish Environmental Management Council - approval of method and aggregation of parameters Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut -- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 6 June 2001: <<< Changes made by Ann-Christin Pålsson, CPM, based on discussions with Caroline Setterwall, Vattenfall AB. Comments: The following changes has been made in the nomenclature for in- and outflows: Mangane in ore -> changed to: Manganese in ore CH4 -> changed to: Methane (to be in accordance with the nomenclature specified in CPM report 2000:2) CN -> changed to: CN- Stone coal -> changed to: Hard coal (to be in accordance with the nomenclature specified in CPM report 2000:2) Other metals -> changed to: Metals Explanations of nomenclature (inserted in Notes for the specific flows): - CN- is Cyanide ion - Reactive waste deposit is waste at landfill that is still reactive. - Inert waste deposit is waste at landfill that are inert. Additional clarifications: - Note that the flows of waste in the table of in- and outflows are internal flows, i.e. they do NOT cross the system boundaries. All waste handling processes is included in the study with respect to use of resources and emissions. - Radioactive waste is accounted for in cubic metres. The product specific requirements for electricity and district heating generation (PSR 1998:1) in the Swedish EPD system states that waste shall be accounted for in gram. However, no conversion factors were given in the study.

	There are also no general conversion factors that are commonly used.

SPINE LCI dataset: Lignite electricity energy system, ETH - full version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Lignite electricity energy system, ETH - full version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures come from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996. Brief description The main phases inventoried in ETH's life cycle study of electricity generation with lignite are: mining, transports and power plant operation. Data has been aquired from literature and figures concerning consumption of energyware and materials, use of land and water, emissions to air (also radioactive) and water and wastes have been picked out from or calculated based on literature for all phases of the life cycle. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle. Detailed description Mining The prospecting of lignite implies test drillings etc but is not inventoried separatly since only a few millimeters of drilling per tonne lignite is needed. Mining depths are mostly less than 200 m but may reach 600 m. Noise (not quantified in this study), radioactive radon, methane and particles are process specific emissions to air and subsoilwater to water. Open pit mining (94% of used lignite in UCPTE) is studied. For the UCPTE average underground mining has been estimated and added. Two to six times the amount of lignite must be dug out, i.e. large strong mashines are needed. Mainly electrified mobile machines are used, often supplied by a nearby lignite power plant (but UCPTE electricity generation mix has been used in the calculations) but also diesel driven machines. Lower heating value of lignite used in UCPTE power plants has an average of 7,9 GJ/tonne lignite. The subsoil water level must be lowered below the seam. Construction and operation of mines have been inventoried. Demolition processes imply depositing of wood and concrete and metalscrap is assumed to be transported to recycling plants. Transports Extracted lignite is transported to nearby power plants on feeder bands, by lorry or train. No processing of lignite is needed. Power plant Construction and area use has been inventoried for two standard plants (100 and 500 MWe). The smaller standard plant is equiped with electrofilter and wet desulphuring with

	lime or limestone, the larger plant has a SCR de-NOx device as well. 70% of the UCPTE lignite power plants belong to the 500 MWe class. Combined heat and power is not studied, i.e. all generated electricity is supposed to come from lignite condensing plants (electricity from CHPs is less than 5% of UCPTE electricity generation). The plants are base load power plants with an average of 6000 h of operation per year. Furnace technology is conventional (i.e. no gasifyers or fluid beds). Average efficiencies of UCPTE power plants have been calculated (30.9%) based on national statistics. Incoming coal (average heating value 8 MJ/kg) is mixed, grinded and dried. Furnace temperatures of 1,300°C giving fly ashes or 1,600°C leading to ash melting are used. Concerning conventional emissions to air national statistics and bottom-up calculations based on existing UCPTE power plants have been used. Emissions of trace elements are estimated and other emissions are calculated based on literature data. Leaching of substances from deposited ashes is included. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries	
Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the industrial revolution I Modified human impact larger than other species', low degree of cultivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of interest. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is different from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH.
Time Boundary	Most background data refer to the period 1990 to 1994. Concerning flue gas cleaning equipment data from 1995/96 has been used where possible. Figures regarding use of materials and mining and processing of coal are older which probably doesn´t affect the result much. Future emissions from deposits for filter ashes are included. Power plant operation is based on the year 1994. Electricity used during the lifecycle has been assumed to be a mix based on the average generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years). All processes, also those conducted in the past, have been assumed to use average technology of the early nineties. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Equipment in mines 30 years Power plant 30 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

Geographical Boundary	Figures are based on average lignite power plants in Austria, Germany, Spain, Ex-Jugoslavia, France and Greece. Lignite mining has been studied in the UCPTE since less than 1% is imported. 67% of lignite used in UCPTE is mined in Germany. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	Data concerning material and energyware use in the construction phase of the mine are rough estimates based on a few real mines. Process specific (i.e. not energyware related) emissions to air from mines have not been included except for radon, methane and particles. The flow of substances in subsoil water is not complete. Use and emissions of lubricating and hydraulic oil is not included. Losses of lignite in the mining area has not been accounted for. Losses of lignite during transport or reloading has not been accounted for. Accidents and filter failures are not considered in the power plant. Most data concerning the power plant are based on assumptions and estimates. Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average electricity generation with lignite in the UCTPE countries.
Method	The figures have been copied from the module ''Electricity of lignite power plant UCPTE'' (Strom ab Braunkohlekraftwerk UCPTE-Mix) in the Ökoinventare von Energiesystemen, ETH Zürich 1996.
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	Multiple flows are reported for several emissions to air. This is because that in the original study emissions to air have been reported in three categories, indicated by one of the letters below following the substance name. - m = mobile (emissions from vehicles) - p = process (process specific emissions as for instance methane emissions during coal mining) - s = stationary (emissions from stationary combustion plants) This categorisation has however not been documented in this specification in the SPINE format.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Area II-III	1840			m2a	Ground	
	Input	Natural resource	Area III-IV	181			m2a	Ground	

	Input	Natural resource	Area II-IV	95.8			m2a	Ground	
	Input	Natural resource	Area IV-IV	0.142			m2a	Ground	
	Input	Natural resource	Area, sea bed II-III	41			m2a	Ground	
	Input	Natural resource	Area, sea bed II-IV	4.23			m2a	Ground	
	Input	Natural resource	Barite	2.58			kg	Ground	
	Input	Natural resource	Bauxite	7.99			kg	Ground	
	Input	Natural resource	Bentonite	4.34			kg	Ground	
	Input	Natural resource	Chromium in ore	0.731			kg	Ground	
	Input	Natural resource	Clay	25.1			kg	Ground	
	Input	Natural resource	Copper in ore	5.46			kg	Ground	
	Input	Natural resource	Crude oil	0.478			tonne	Ground	
	Input	Natural resource	Gravel	689			kg	Ground	
	Input	Natural resource	Hydro energy	0.00624			TJ	Water	
	Input	Natural resource	Iron in ore	319			kg	Ground	
	Input	Natural resource	Lead in ore	0.0394			kg	Ground	
	Input	Natural resource	Lignite	414000			kg	Ground	
	Input	Natural resource	Limestone	1880			kg	Ground	
	Input	Natural resource	Manganese in ore	0.455			kg	Ground	
	Input	Natural resource	Mine gas (methane)	26.4			kg	Ground	
	Input	Natural resource	Natural gas	32.7			Nm3	Ground	
	Input	Natural resource	Natural gas	327			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.299			kg	Ground	
	Input	Natural resource	Palladium in ore	9.53E-08			kg	Ground	
	Input	Natural resource	Platinum in ore	0.000000108			kg	Ground	
	Input	Natural resource	Rhodium in ore	0.000000101			kg	Ground	
	Input	Natural resource	Rock salt	36.2			kg	Ground	
	Input	Natural resource	Sand	10.3			kg	Ground	
	Input	Natural resource	Stone coal	1400			kg	Ground	
	Input	Natural resource	Turbine water amount	32800			m3	Water	
	Input	Natural resource	Uranium in ore	0.0947			kg	Ground	
	Input	Natural resource	Water	13500000			kg	Ground	
	Input	Natural resource	Wood	0.0275			tonne	Ground	
	Input	Natural resource	Working amount in water storages	136			m3a	Water	
	Input	Natural resource	Zinc in ore	0.00163			kg	Ground	
	Input	Refined resource	Cobalt	0.000000616			kg	Technosphere	
	Input	Refined resource	Molybdenum	0.000000361			kg	Technosphere	
	Input	Refined resource	Rhenium	0.000000092			kg	Technosphere	

	Input	Refined resource	Silver	0.00151			kg	Technosphere	
	Input	Refined resource	Tin	0.000836			kg	Technosphere	
	Output	Emission	1,1,1-Trichloroethane	3.29E-08			kg	Fresh water	
	Output	Emission	1,2-Dichloroethane	0.000011			kg	Fresh water	
	Output	Emission	1,2-Dichloroethane	0.0000213			kg	Air	
	Output	Emission	Acenaphthylene	0.000347			kg	Fresh water	
	Output	Emission	Acetaldehyde	0.00209			kg	Air	
	Output	Emission	Acetic acid	0.00943			kg	Air	
	Output	Emission	Acetone	0.00208			kg	Air	
	Output	Emission	Acetylene	0.000252			kg	Air	
	Output	Emission	Acids	0.00138			kg	Fresh water	
	Output	Emission	Acroleine	0.000000207			kg	Air	
	Output	Emission	Ag	0.0000127			kg	Sea water	
	Output	Emission	Ag	0.000023			kg	Fresh water	
	Output	Emission	Ag-110m	0.0000392			kBq	Air	
	Output	Emission	Ag-110m	0.267			kBq	Fresh water	
	Output	Emission	Al	0.0000345			kg	Sea water	
	Output	Emission	Al	0.00011			kg	Air	
	Output	Emission	Al	0.00219			kg	Air	
	Output	Emission	Al	0.0338			kg	Ground	
	Output	Emission	Al	2.29			kg	Fresh water	
	Output	Emission	Al	4.75			kg	Air	
	Output	Emission	Aldehydes	0.0000756			kg	Air	
	Output	Emission	Alkanes	0.000399			kg	Fresh water	
	Output	Emission	Alkanes	0.00275			kg	Sea water	
	Output	Emission	Alkanes	0.00953			kg	Air	
	Output	Emission	Alkanes	0.727			kg	Air	
	Output	Emission	Alkenes	0.00000856			kg	Air	
	Output	Emission	Alkenes	0.0000368			kg	Fresh water	
	Output	Emission	Alkenes	0.000254			kg	Sea water	
	Output	Emission	Alkenes	0.708			kg	Air	
	Output	Emission	Alpha radiator	0.0000317			kBq	Fresh water	
	Output	Emission	Am-241	0.000729			kBq	Air	
	Output	Emission	Am-241	0.0961			kBq	Sea water	
	Output	Emission	AOX	0.0000326			kg	Sea water	
	Output	Emission	AOX	0.0000571			kg	Fresh water	
	Output	Emission	Ar-41	85			kBq	Air	
	Output	Emission	Aromates	0.000000856			kg	Air	
	Output	Emission	Aromates	0.000914			kg	Air	
	Output	Emission	Aromatics	0.00151			kg	Fresh water	
	Output	Emission	Aromatics	0.0133			kg	Sea water	
	Output	Emission	As	0.00000696			kg	Sea water	
	Output	Emission	As	0.000011			kg	Air	
	Output	Emission	As	0.0000135			kg	Ground	
	Output	Emission	As	0.000034			kg	Air	
	Output	Emission	As	0.00456			kg	Fresh water	
	Output	Emission	As	0.0119			kg	Air	
	Output	Emission	B	0.00000567			kg	Air	
	Output	Emission	B	0.000427			kg	Sea water	
	Output	Emission	B	0.00312			kg	Fresh water	
	Output	Emission	B	14.5			kg	Air	
	Output	Emission	Ba	0.0000208			kg	Air	
	Output	Emission	Ba	0.0529			kg	Sea water	
	Output	Emission	Ba	0.139			kg	Air	
	Output	Emission	Ba	0.186			kg	Fresh water	
	Output	Emission	Ba-140	0.000154			kBq	Air	
	Output	Emission	Ba-140	0.000492			kBq	Fresh water	
	Output	Emission	Barite	0.51			kg	Sea water	
	Output	Emission	Be	0.000000265			kg	Air	
	Output	Emission	Be	0.00000331			kg	Fresh water	
	Output	Emission	Be	0.00139			kg	Air	
	Output	Emission	Benzaldehyde	0.000000108			kg	Air	
	Output	Emission	Benzene	0.0000319			kg	Air	
	Output	Emission	Benzene	0.00043			kg	Fresh water	

	Output	Emission	Benzene	0.00275			kg	Sea water	
	Output	Emission	Benzene	0.00438			kg	Air	
	Output	Emission	Benzene	0.00543			kg	Air	
	Output	Emission	Benzo(a)pyrene	0.0000324			kg	Air	
	Output	Emission	Benzo(a)pyrene	5.93E-08			kg	Air	
	Output	Emission	BOD	0.000526			kg	Sea water	
	Output	Emission	BOD	0.0366			kg	Fresh water	
	Output	Emission	Br	0.0000159			kg	Air	
	Output	Emission	Br	0.7			kg	Air	
	Output	Emission	Butane	0.0404			kg	Air	
	Output	Emission	Butane	0.0705			kg	Air	
	Output	Emission	Butene	0.00224			kg	Air	
	Output	Emission	C	0.104			kg	Ground	
	Output	Emission	C-14	4.86			kBq	Sea water	
	Output	Emission	C-14	58.7			kBq	Air	
	Output	Emission	Ca	0.000095			kg	Air	
	Output	Emission	Ca	0.012			kg	Air	
	Output	Emission	Ca	0.135			kg	Ground	
	Output	Emission	Ca	0.682			kg	Sea water	
	Output	Emission	Ca	11			kg	Fresh water	
	Output	Emission	Ca	20			kg	Air	
	Output	Emission	Cd	0.000000324			kg	Air	
	Output	Emission	Cd	0.000000775			kg	Ground	
	Output	Emission	Cd	0.0000133			kg	Sea water	
	Output	Emission	Cd	0.000142			kg	Air	
	Output	Emission	Cd	0.000261			kg	Fresh water	
	Output	Emission	Cd	0.00914			kg	Air	
	Output	Emission	Cd-109	0.00000285			kBq	Fresh water	
	Output	Emission	Ce-141	0.00000363			kBq	Air	
	Output	Emission	Ce-141	0.0000736			kBq	Fresh water	
	Output	Emission	Ce-144	0.000021			kBq	Fresh water	
	Output	Emission	Ce-144	0.00775			kBq	Air	
	Output	Emission	Ce-144	2.2			kBq	Sea water	
	Output	Emission	CFC-11	0.00003			kg	Air	
	Output	Emission	CFC-114	0.000793			kg	Air	
	Output	Emission	CFC-12	0.00000645			kg	Air	
	Output	Emission	CFC-13	0.00000405			kg	Air	
	Output	Emission	CH4	0.00704			kg	Air	
	Output	Emission	CH4	28.1			kg	Air	
	Output	Emission	CH4	3.39			kg	Air	
	Output	Emission	Chlorinated solvents	0.0000354			kg	Fresh water	
	Output	Emission	Chlorobenzenes	3.96E-10			kg	Fresh water	
	Output	Emission	Cl-	10.9			kg	Sea water	
	Output	Emission	Cl-	26.5			kg	Fresh water	
	Output	Emission	ClO-	0.00302			kg	Sea water	
	Output	Emission	ClO-	1.15			kg	Fresh water	
	Output	Emission	Cm alpha	0.00116			kBq	Air	
	Output	Emission	Cm alpha	0.127			kBq	Sea water	
	Output	Emission	Cm-242	3.84E-09			kBq	Air	
	Output	Emission	Cm-244	3.49E-08			kBq	Air	
	Output	Emission	CN	0.0000942			kg	Air	
	Output	Emission	CN	5.39E-12			kg	Air	
	Output	Emission	CN-	0.0000345			kg	Sea water	
	Output	Emission	CN-	0.00144			kg	Fresh water	
	Output	Emission	Co	0.000000649			kg	Ground	
	Output	Emission	Co	0.00000691			kg	Air	
	Output	Emission	Co	0.0000288			kg	Air	
	Output	Emission	Co	0.00447			kg	Fresh water	
	Output	Emission	Co	0.0269			kg	Air	
	Output	Emission	CO	0.187			kg	Air	
	Output	Emission	CO	4.79			kg	Air	
	Output	Emission	CO	40.2			kg	Air	
	Output	Emission	CO2	370000			kg	Air	
	Output	Emission	CO2	85			kg	Air	
	Output	Emission	CO2	894			kg	Air	

	Output	Emission	Co-57	0.000505			kBq	Fresh water	
	Output	Emission	Co-57	6.72E-08			kBq	Air	
	Output	Emission	Co-58	0.00111			kBq	Air	
	Output	Emission	Co-58	0.421			kBq	Fresh water	
	Output	Emission	Co-60	0.00165			kBq	Air	
	Output	Emission	Co-60	0.438			kBq	Fresh water	
	Output	Emission	Co-60	20.8			kBq	Sea water	
	Output	Emission	COD	0.0144			kg	Sea water	
	Output	Emission	COD	0.0836			kg	Fresh water	
	Output	Emission	Cr	0.00000546			kg	Air	
	Output	Emission	Cr	0.000169			kg	Ground	
	Output	Emission	Cr	0.000319			kg	Air	
	Output	Emission	Cr	0.0283			kg	Air	
	Output	Emission	Cr(VI)	0.00000368			kg	Fresh water	
	Output	Emission	Cr3+	0.000207			kg	Sea water	
	Output	Emission	Cr3+	0.0235			kg	Fresh water	
	Output	Emission	Cr-51	0.000138			kBq	Air	
	Output	Emission	Cr-51	0.0108			kBq	Fresh water	
	Output	Emission	Cs	0.00000295			kg	Fresh water	
	Output	Emission	Cs	0.0000211			kg	Sea water	
	Output	Emission	Cs-134	0.0277			kBq	Air	
	Output	Emission	Cs-134	0.0554			kBq	Fresh water	
	Output	Emission	Cs-134	4.86			kBq	Sea water	
	Output	Emission	Cs-136	0.00000264			kBq	Fresh water	
	Output	Emission	Cs-137	0.0535			kBq	Air	
	Output	Emission	Cs-137	0.125			kBq	Fresh water	
	Output	Emission	Cs-137	45.1			kBq	Sea water	
	Output	Emission	Cu	0.00000324			kg	Ground	
	Output	Emission	Cu	0.0000289			kg	Sea water	
	Output	Emission	Cu	0.000221			kg	Air	
	Output	Emission	Cu	0.00116			kg	Air	
	Output	Emission	Cu	0.0156			kg	Fresh water	
	Output	Emission	Cu	0.0413			kg	Air	
	Output	Emission	Di-(2-ethylhexyl) phthalate	1.22E-09			kg	Fresh water	
	Output	Emission	Dibutyl p-phthalate	3.51E-08			kg	Fresh water	
	Output	Emission	Dichloromethane	0.00018			kg	Air	
	Output	Emission	Dichloromethane	0.000235			kg	Fresh water	
	Output	Emission	Different beta	0.000005			kBq	Air	
	Output	Emission	Dimethyl p-phthalate	0.000000221			kg	Fresh water	
	Output	Emission	Dioxin (TCDD)	17300			ng	Air	
	Output	Emission	Dissolved organic carbon	0.00102			kg	Sea water	
	Output	Emission	Dissolved organic carbon	0.00381			kg	Fresh water	
	Output	Emission	Dissolved solids	0.0799			kg	Sea water	
	Output	Emission	Dissolved solids	0.86			kg	Fresh water	
	Output	Emission	Ethane	0.067			kg	Air	
	Output	Emission	Ethane	0.136			kg	Air	
	Output	Emission	Ethanol	0.0000195			kg	Air	
	Output	Emission	Ethanol	0.00417			kg	Air	
	Output	Emission	Ethene	0.00541			kg	Air	
	Output	Emission	Ethene	0.0457			kg	Air	
	Output	Emission	Ethylbenzene	0.0000643			kg	Fresh water	
	Output	Emission	Ethylbenzene	0.000508			kg	Sea water	
	Output	Emission	Ethylbenzene	0.000879			kg	Air	
	Output	Emission	Ethylbenzene	0.711			kg	Air	
	Output	Emission	F-	0.000211			kg	Sea water	
	Output	Emission	F-	0.0604			kg	Fresh water	
	Output	Emission	Fe	0.00021			kg	Air	
	Output	Emission	Fe	0.00246			kg	Sea water	
	Output	Emission	Fe	0.0197			kg	Air	
	Output	Emission	Fe	0.0677			kg	Ground	
	Output	Emission	Fe	5.42			kg	Air	
	Output	Emission	Fe	663			kg	Fresh water	
	Output	Emission	Fe-59	0.00000152			kBq	Air	
	Output	Emission	Fe-59	0.00000872			kBq	Fresh water	
	Output	Emission	Fission and rad. prod.	0.287			kBq	Fresh water	

	Output	Emission	Formaldehyde	0.00000302			kg	Fresh water	
	Output	Emission	Formaldehyde	0.0000446			kg	Air	
	Output	Emission	Formaldehyde	0.204			kg	Air	
	Output	Emission	Glutaraldehyde	0.000063			kg	Sea water	
	Output	Emission	H-1301	0.000186			kg	Air	
	Output	Emission	H2S	0.000449			kg	Fresh water	
	Output	Emission	H2S	0.005			kg	Air	
	Output	Emission	H2S	0.0174			kg	Air	
	Output	Emission	H-3	139000			kBq	Sea water	
	Output	Emission	H-3	5110			kBq	Fresh water	
	Output	Emission	H-3	605			kBq	Air	
	Output	Emission	HCFC-21	0.000636			kg	Air	
	Output	Emission	HCFC-22	0.00000706			kg	Air	
	Output	Emission	HCl	0.019			kg	Air	
	Output	Emission	HCl	136			kg	Air	
	Output	Emission	He	0.0043			kg	Air	
	Output	Emission	He	0.0287			kg	Air	
	Output	Emission	Heat	0.0000532			TJ	Ground	
	Output	Emission	Heat	0.000986			TJ	Sea water	
	Output	Emission	Heat	0.00132			TJ	Air	
	Output	Emission	Heat	0.0325			TJ	Air	
	Output	Emission	Heat	0.455			TJ	Fresh water	
	Output	Emission	Heat	2.44			TJ	Air	
	Output	Emission	Heptane	0.00879			kg	Air	
	Output	Emission	Hexachlorobenzene	4.27E-10			kg	Air	
	Output	Emission	Hexachloroethane	2.43E-10			kg	Fresh water	
	Output	Emission	Hexafluoroethane	0.0000869			kg	Air	
	Output	Emission	Hexane	0.0184			kg	Air	
	Output	Emission	HF	0.00369			kg	Air	
	Output	Emission	HF	13.8			kg	Air	
	Output	Emission	HFC-134a	4.21E-17			kg	Air	
	Output	Emission	Hg	0.000000196			kg	Ground	
	Output	Emission	Hg	0.000000293			kg	Sea water	
	Output	Emission	Hg	0.00000032			kg	Air	
	Output	Emission	Hg	0.0000385			kg	Fresh water	
	Output	Emission	Hg	0.0000442			kg	Air	
	Output	Emission	Hg	0.0194			kg	Air	
	Output	Emission	HOCl	0.00302			kg	Sea water	
	Output	Emission	HOCl	1.15			kg	Fresh water	
	Output	Emission	Hydrocarbons	0.000663			kg	Fresh water	
	Output	Emission	I	0.0000126			kg	Air	
	Output	Emission	I	0.000267			kg	Fresh water	
	Output	Emission	I	0.00211			kg	Sea water	
	Output	Emission	I	0.535			kg	Air	
	Output	Emission	I-129	0.208			kBq	Air	
	Output	Emission	I-129	13.9			kBq	Sea water	
	Output	Emission	I-131	0.00925			kBq	Fresh water	
	Output	Emission	I-131	0.0233			kBq	Air	
	Output	Emission	I-133	0.00225			kBq	Fresh water	
	Output	Emission	I-133	0.0129			kBq	Air	
	Output	Emission	I-135	0.0194			kBq	Air	
	Output	Emission	K	0.0548			kg	Air	
	Output	Emission	K	0.092			kg	Sea water	
	Output	Emission	K	0.607			kg	Air	
	Output	Emission	K	0.698			kg	Fresh water	
	Output	Emission	K-40	0.349			kBq	Fresh water	
	Output	Emission	K-40	6.27			kBq	Air	
	Output	Emission	Kr-85	3590000			kBq	Air	
	Output	Emission	Kr-85m	4.31			kBq	Air	
	Output	Emission	Kr-87	1.92			kBq	Air	
	Output	Emission	Kr-88	169			kBq	Air	
	Output	Emission	Kr-89	1.35			kBq	Air	
	Output	Emission	La	0.00000104			kg	Air	
	Output	Emission	La	0.0033			kg	Air	
	Output	Emission	La-140	0.0000969			kBq	Air	

	Output	Emission	La-140	0.000102			kBq	Fresh water	
	Output	Emission	Methanol	0.00423			kg	Air	
	Output	Emission	Methyl Tertiary Butyl Ether	0.000000123			kg	Fresh water	
	Output	Emission	Methyl Tertiary Butyl Ether	0.00000227			kg	Air	
	Output	Emission	Methyl Tertiary Butyl Ether	7.02E-08			kg	Sea water	
	Output	Emission	Mg	0.00148			kg	Air	
	Output	Emission	Mg	0.0138			kg	Sea water	
	Output	Emission	Mg	1.88			kg	Fresh water	
	Output	Emission	Mg	3.01			kg	Air	
	Output	Emission	Mn	0.00114			kg	Sea water	
	Output	Emission	Mn	0.00135			kg	Ground	
	Output	Emission	Mn	0.0147			kg	Air	
	Output	Emission	Mn	0.0196			kg	Air	
	Output	Emission	Mn	0.0523			kg	Fresh water	
	Output	Emission	Mn-54	0.0000397			kBq	Air	
	Output	Emission	Mn-54	0.0196			kBq	Fresh water	
	Output	Emission	Mn-54	3.24			kBq	Sea water	
	Output	Emission	Mo	0.000000309			kg	Air	
	Output	Emission	Mo	0.00000693			kg	Sea water	
	Output	Emission	Mo	0.00000879			kg	Air	
	Output	Emission	Mo	0.00778			kg	Fresh water	
	Output	Emission	Mo	0.0126			kg	Air	
	Output	Emission	Mo-99	0.0000344			kBq	Fresh water	
	Output	Emission	N	0.0000397			kg	Ground	
	Output	Emission	N total	0.0132			kg	Sea water	
	Output	Emission	N total	0.0272			kg	Fresh water	
	Output	Emission	N2	0.0871			kg	Air	
	Output	Emission	N2O	0.00332			kg	Air	
	Output	Emission	N2O	0.163			kg	Air	
	Output	Emission	N2O	1.68			kg	Air	
	Output	Emission	Na	0.000104			kg	Air	
	Output	Emission	Na	0.000561			kg	Air	
	Output	Emission	Na	0.978			kg	Air	
	Output	Emission	Na	6.01			kg	Fresh water	
	Output	Emission	Na	6.58			kg	Sea water	
	Output	Emission	Na-24	0.0152			kBq	Fresh water	
	Output	Emission	Nb-95	0.00000703			kBq	Air	
	Output	Emission	Nb-95	0.000279			kBq	Fresh water	
	Output	Emission	NH3	0.000892			kg	Air	
	Output	Emission	NH3	1.8			kg	Air	
	Output	Emission	NH4+ as N	0.00988			kg	Sea water	
	Output	Emission	NH4+ as N	0.0429			kg	Fresh water	
	Output	Emission	Ni	0.00000487			kg	Ground	
	Output	Emission	Ni	0.0000498			kg	Sea water	
	Output	Emission	Ni	0.000546			kg	Air	
	Output	Emission	Ni	0.00206			kg	Air	
	Output	Emission	Ni	0.0117			kg	Fresh water	
	Output	Emission	Ni	0.0339			kg	Air	
	Output	Emission	NMVOC	0.0713			kg	Air	
	Output	Emission	NMVOC	1.02			kg	Air	
	Output	Emission	NMVOC	4.55			kg	Air	
	Output	Emission	NO2-	0.00000916			kg	Fresh water	
	Output	Emission	NO2-	0.0037			kg	Sea water	
	Output	Emission	NO3-	0.00568			kg	Sea water	
	Output	Emission	NO3-	0.0469			kg	Fresh water	
	Output	Emission	Noble gases (radioactive)	5.2			kBq	Air	
	Output	Emission	NOx	0.939			kg	Air	
	Output	Emission	NOx	1.06			kg	Air	
	Output	Emission	NOx	556			kg	Air	
	Output	Emission	Np-237	0.00613			kBq	Sea water	
	Output	Emission	Np-237	3.82E-08			kBq	Air	
	Output	Emission	Nuclide mix	0.000208			kBq	Fresh water	
	Output	Emission	Oil	0.000434			kg	Ground	
	Output	Emission	Oil	0.0106			kg	Fresh water	
	Output	Emission	Oil	0.442			kg	Sea water	

	Output	Emission	Organic N	0.0018			kg	Sea water	
	Output	Emission	Organic N	0.00319			kg	Fresh water	
	Output	Emission	P	0.000015			kg	Air	
	Output	Emission	P	0.0000641			kg	Air	
	Output	Emission	P	0.0018			kg	Ground	
	Output	Emission	P	0.0213			kg	Ground	
	Output	Emission	P	0.0633			kg	Air	
	Output	Emission	Pa-234m	0.0232			kBq	Air	
	Output	Emission	Pa-234m	0.429			kBq	Fresh water	
	Output	Emission	PAH	0.000000625			kg	Air	
	Output	Emission	PAH	0.0000808			kg	Fresh water	
	Output	Emission	PAH	0.000275			kg	Sea water	
	Output	Emission	PAH	0.00355			kg	Air	
	Output	Emission	Particles	0.0644			kg	Air	
	Output	Emission	Particles	170			kg	Air	
	Output	Emission	Particles	87.6			kg	Air	
	Output	Emission	Pb	0.00000718			kg	Sea water	
	Output	Emission	Pb	0.0000151			kg	Ground	
	Output	Emission	Pb	0.000582			kg	Air	
	Output	Emission	Pb	0.000986			kg	Air	
	Output	Emission	Pb	0.0192			kg	Fresh water	
	Output	Emission	Pb	0.0276			kg	Air	
	Output	Emission	Pb-210	0.258			kBq	Air	
	Output	Emission	Pb-210	0.278			kBq	Fresh water	
	Output	Emission	Pb-210	22			kBq	Air	
	Output	Emission	Pentachlorobenzene	1.14E-09			kg	Air	
	Output	Emission	Pentachlorophenol	1.84E-10			kg	Air	
	Output	Emission	Pentane	0.0465			kg	Air	
	Output	Emission	Pentane	0.493			kg	Air	
	Output	Emission	Phenol	0.000176			kg	Air	
	Output	Emission	Phenol	0.00234			kg	Fresh water	
	Output	Emission	Phenol	0.00247			kg	Sea water	
	Output	Emission	Phosphoric compound	0.0000201			kg	Fresh water	
	Output	Emission	Pm-147	0.0197			kBq	Air	
	Output	Emission	Po-210	0.258			kBq	Air	
	Output	Emission	Po-210	0.278			kBq	Fresh water	
	Output	Emission	Po-210	40.2			kBq	Air	
	Output	Emission	PO43-	0.0000694			kg	Sea water	
	Output	Emission	PO43-	0.138			kg	Fresh water	
	Output	Emission	Propane	0.0512			kg	Air	
	Output	Emission	Propane	0.12			kg	Air	
	Output	Emission	Propene	0.00196			kg	Air	
	Output	Emission	Propene	0.0528			kg	Air	
	Output	Emission	Propionic acid	0.000145			kg	Air	
	Output	Emission	Propionic aldehyde	0.000000108			kg	Air	
	Output	Emission	Pt	0.000000121			kg	Air	
	Output	Emission	Pu alpha	0.00231			kBq	Air	
	Output	Emission	Pu alpha	0.382			kBq	Sea water	
	Output	Emission	Pu-238	8.68E-08			kBq	Air	
	Output	Emission	Pu-241 beta	0.0637			kBq	Air	
	Output	Emission	Pu-241 beta	9.49			kBq	Sea water	
	Output	Emission	Ra-224	0.133			kBq	Fresh water	
	Output	Emission	Ra-224	1.06			kBq	Sea water	
	Output	Emission	Ra-226	0.727			kBq	Air	
	Output	Emission	Ra-226	1770			kBq	Fresh water	
	Output	Emission	Ra-226	2.11			kBq	Sea water	
	Output	Emission	Ra-226	5.68			kBq	Air	
	Output	Emission	Ra-228	0.267			kBq	Fresh water	
	Output	Emission	Ra-228	2.11			kBq	Sea water	
	Output	Emission	Ra-228	3.07			kBq	Air	
	Output	Emission	Rb	0.0000291			kg	Fresh water	
	Output	Emission	Rb	0.000211			kg	Sea water	
	Output	Emission	Rn-220	401			kBq	Air	
	Output	Emission	Rn-222	56800			kBq	Air	
	Output	Emission	Rn-222	717			kBq	Air	

	Output	Emission	Rn-222 (long term)	5150000			kBq	Air	
	Output	Emission	Ru-103	0.000000398			kBq	Air	
	Output	Emission	Ru-103	0.000165			kBq	Fresh water	
	Output	Emission	Ru-106	0.231			kBq	Air	
	Output	Emission	Ru-106	23.1			kBq	Sea water	
	Output	Emission	S	0.0203			kg	Ground	
	Output	Emission	S2-	0.000277			kg	Sea water	
	Output	Emission	S2-	0.000528			kg	Fresh water	
	Output	Emission	Salt	1450			kg	Fresh water	
	Output	Emission	Sb	0.000000113			kg	Air	
	Output	Emission	Sb	0.0000447			kg	Fresh water	
	Output	Emission	Sb	0.0154			kg	Air	
	Output	Emission	Sb-122	0.000492			kBq	Fresh water	
	Output	Emission	Sb-124	0.0000107			kBq	Air	
	Output	Emission	Sb-124	0.0689			kBq	Fresh water	
	Output	Emission	Sb-125	0.00000138			kBq	Air	
	Output	Emission	Sb-125	0.00401			kBq	Fresh water	
	Output	Emission	Sc	0.000000409			kg	Air	
	Output	Emission	Sc	0.00049			kg	Air	
	Output	Emission	Se	0.0000032			kg	Air	
	Output	Emission	Se	0.00000709			kg	Sea water	
	Output	Emission	Se	0.000889			kg	Air	
	Output	Emission	Se	0.0115			kg	Fresh water	
	Output	Emission	Se	0.108			kg	Air	
	Output	Emission	Si	0.000095			kg	Air	
	Output	Emission	Si	0.000853			kg	Fresh water	
	Output	Emission	Si	0.00258			kg	Air	
	Output	Emission	Si	48.1			kg	Air	
	Output	Emission	Sn	0.000000208			kg	Air	
	Output	Emission	Sn	0.0000184			kg	Fresh water	
	Output	Emission	Sn	0.00162			kg	Air	
	Output	Emission	SO2	1.2			kg	Air	
	Output	Emission	SO2	2.33			kg	Air	
	Output	Emission	SO2	3620			kg	Air	
	Output	Emission	SO32-	0.000741			kg	Fresh water	
	Output	Emission	SO42-	0.164			kg	Sea water	
	Output	Emission	SO42-	1400			kg	Fresh water	
	Output	Emission	Sr	0.0000208			kg	Air	
	Output	Emission	Sr	0.0436			kg	Fresh water	
	Output	Emission	Sr	0.127			kg	Sea water	
	Output	Emission	Sr	0.13			kg	Air	
	Output	Emission	Sr-89	0.0000695			kBq	Air	
	Output	Emission	Sr-89	0.00111			kBq	Fresh water	
	Output	Emission	Sr-90	0.000411			kBq	Fresh water	
	Output	Emission	Sr-90	0.0382			kBq	Air	
	Output	Emission	Sr-90	4.63			kBq	Sea water	
	Output	Emission	Suspended solids	0.349			kg	Fresh water	
	Output	Emission	Suspended solids	1.58			kg	Sea water	
	Output	Emission	Tc-99	0.00000162			kBq	Air	
	Output	Emission	Tc-99	2.43			kBq	Sea water	
	Output	Emission	Tc-99m	0.000232			kBq	Fresh water	
	Output	Emission	Te-123	0.0000208			kBq	Fresh water	
	Output	Emission	Te-123m	0.000175			kBq	Air	
	Output	Emission	Te-132	0.00000851			kBq	Fresh water	
	Output	Emission	Tetrachloroethene	2.89E-08			kg	Fresh water	
	Output	Emission	Tetrachloromethane	0.0000348			kg	Air	
	Output	Emission	Tetrachloromethane	4.41E-08			kg	Fresh water	
	Output	Emission	Tetrafluoromethane	0.000782			kg	Air	
	Output	Emission	Th	0.000000409			kg	Air	
	Output	Emission	Th	0.00155			kg	Air	
	Output	Emission	Th-228	0.533			kBq	Fresh water	
	Output	Emission	Th-228	2.6			kBq	Air	
	Output	Emission	Th-228	4.23			kBq	Sea water	
	Output	Emission	Th-230	0.258			kBq	Air	
	Output	Emission	Th-230	67.1			kBq	Fresh water	

	Output	Emission	Th-232	0.0651			kBq	Fresh water	
	Output	Emission	Th-232	1.63			kBq	Air	
	Output	Emission	Th-234	0.0232			kBq	Air	
	Output	Emission	Th-234	0.433			kBq	Fresh water	
	Output	Emission	Ti	0.000063			kg	Air	
	Output	Emission	Ti	0.103			kg	Air	
	Output	Emission	Ti	0.134			kg	Fresh water	
	Output	Emission	Tl	0.000000104			kg	Air	
	Output	Emission	Tl	0.0000811			kg	Air	
	Output	Emission	Toluene	0.00035			kg	Fresh water	
	Output	Emission	Toluene	0.00228			kg	Sea water	
	Output	Emission	Toluene	0.00545			kg	Air	
	Output	Emission	Toluene	0.359			kg	Air	
	Output	Emission	Total organic carbon	0.013			kg	Fresh water	
	Output	Emission	Total organic carbon	0.109			kg	Sea water	
	Output	Emission	Total organic carbon	0.152			kg	Sea water	
	Output	Emission	Total organic carbon	1.03			kg	Fresh water	
	Output	Emission	Tributyltin	0.0000765			kg	Sea water	
	Output	Emission	Trichloroethene	0.00000182			kg	Fresh water	
	Output	Emission	Trichloromethane	0.000000562			kg	Air	
	Output	Emission	Trichloromethane	0.00000669			kg	Fresh water	
	Output	Emission	Triethylene glycol	0.00102			kg	Sea water	
	Output	Emission	Triethylene glycol	0.00381			kg	Fresh water	
	Output	Emission	U	0.000000208			kg	Air	
	Output	Emission	U	0.00167			kg	Air	
	Output	Emission	U alpha	0.0799			kBq	Sea water	
	Output	Emission	U alpha	0.83			kBq	Air	
	Output	Emission	U alpha	28			kBq	Fresh water	
	Output	Emission	U-234	0.278			kBq	Air	
	Output	Emission	U-234	0.573			kBq	Fresh water	
	Output	Emission	U-235	0.0135			kBq	Air	
	Output	Emission	U-235	0.854			kBq	Fresh water	
	Output	Emission	U-238	0.274			kBq	Air	
	Output	Emission	U-238	1.45			kBq	Fresh water	
	Output	Emission	U-238	4.75			kBq	Air	
	Output	Emission	V	0.00000693			kg	Sea water	
	Output	Emission	V	0.000043			kg	Air	
	Output	Emission	V	0.00145			kg	Air	
	Output	Emission	V	0.0119			kg	Fresh water	
	Output	Emission	V	0.0791			kg	Air	
	Output	Emission	W	0.0000849			kg	Fresh water	
	Output	Emission	Vinyl chloride	0.00000347			kg	Air	
	Output	Emission	Vinyl chloride	8.19E-09			kg	Fresh water	
	Output	Emission	VOC	0.000933			kg	Fresh water	
	Output	Emission	VOC	0.0074			kg	Sea water	
	Output	Emission	Xe-121m	8.84			kBq	Air	
	Output	Emission	Xe-133	2580			kBq	Air	
	Output	Emission	Xe-133m	1.3			kBq	Air	
	Output	Emission	Xe-135	441			kBq	Air	
	Output	Emission	Xe-135m	44			kBq	Air	
	Output	Emission	Xe-137	1.09			kBq	Air	
	Output	Emission	Xe-138	11.9			kBq	Air	
	Output	Emission	Xylene	0.000296			kg	Fresh water	
	Output	Emission	Xylene	0.00199			kg	Sea water	
	Output	Emission	Xylol	0.00456			kg	Air	
	Output	Emission	Xylol	3.02			kg	Air	
	Output	Emission	Y-90	0.0000568			kBq	Fresh water	
	Output	Emission	Zn	0.0000694			kg	Sea water	
	Output	Emission	Zn	0.00054			kg	Ground	
	Output	Emission	Zn	0.000888			kg	Air	
	Output	Emission	Zn	0.00618			kg	Air	
	Output	Emission	Zn	0.0389			kg	Fresh water	
	Output	Emission	Zn	0.169			kg	Air	
	Output	Emission	Zn-65	0.000171			kBq	Air	
	Output	Emission	Zn-65	0.032			kBq	Fresh water	

	Output	Emission	Zr	0.00000504			kg	Air	
	Output	Emission	Zr-95	0.00000254			kBq	Air	
	Output	Emission	Zr-95	0.0000679			kBq	Fresh water	
	Output	Emission	Zr-95	0.197			kBq	Sea water	
	Output	Product	Electricity	1			TJ	Technosphere	
	Output	Residue	Hazardous waste	15.7			kg	Technosphere	
	Output	Residue	Highly radioactive waste	0.000197			kg	Technosphere	
	Output	Residue	Inert waste deposit	1270			kg	Technosphere	
	Output	Residue	Low radioactive waste	0.0000162			kg	Technosphere	
	Output	Residue	Medium and low radioactive waste	0.000198			kg	Technosphere	
	Output	Residue	Reactive waste deposit	16.8			kg	Technosphere	
	Output	Residue	Waste deposit	47000			kg	Technosphere	
	Output	Residue	Waste in land farming	3.56			kg	Technosphere	
	Output	Residue	Waste to incineration	0.408			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www.energieforschung.ch. --- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden ---
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their life cycles. The results can be used in life cycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans.
Detailed Purpose	ETH:s aim was to describe the average situation in the UCPTE concerning electricity generation with lignite. With the help of assumptions and simplifications following phases of the life cycle are described: mining (open pit), transports and power plant.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Data reported here is supposed to be representative for lignite based elctricity generation in the UCPTE countries in 1994.
About Data	Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided). Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of metadata describing the ETH study has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger

	Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut

SPINE LCI dataset: Limestone quarrying. ESA-DBP

Administrative	
Finished	Y
Date Completed	1996
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Limestone quarrying. ESA-DBP
Functional Unit	1kg of limestone
Functional Unit Explanation	Unknown
Process Type	Gate to gate
Site	Unknown
Sector	Mining and quarrying
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''The process step to get limestone include excavation, crushing, grinding, sieving, washing and drying''. The input for the process is a limestone rock. This process is included in the system described in: Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Coal mining and cleaning. ESA-DBP - Cast iron production. ESA-DBP - Sand extraction and processing. ESA-DBP - Sinter plant's process ESA-DBP - Uranium ore extraction and enrichment. ESA-DBP - Production of pig iron - blast furnace process. ESA-DBP

System Boundaries	
Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) emissions to air, emissions to water, and waste generation.
Time Boundary	1994
Geographical Boundary	Unknown
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1994

Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other report.
Literature Reference	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Data for particular process come from: Landbank Environmental Research & Consulting (1994), The Phosphate Report, Landbank
Notes	Multiple flows are reported for several emissions to air. This is because that in the original study emissions to air have been reported in three categories, indicated by one of the letters below following the substance name. - m = mobile (emissions from vehicles) - p = process (process specific emissions as for instance methane emissions during coal mining) - s = stationary (emissions from stationary combustion plants) This categorisation has however not been documented in this specification in the SPINE format.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Limestone rock	1.13E+00			kg	Ground	Not known
	Input	Refined resource	Electricity	2.10E-01			MJ	Technosphere	Not known
	Input	Refined resource	Heat	1.10E-01			MJ	Technosphere	Not known
	Input	Resource	Process air	1.05E+00			kg	Air	Not known
Notes: NB: no information whether the water is fresh or reused.	Input	Resource	Process water	1.05E+00			kg	Water	Not known
	Output	Emission	Particulates	3.00E-02			kg	Air	Not known
	Output	Emission	Waste air	1.07E+00			kg	Air	Not known
	Output	Product	Limestone	1.00E+00			kg	Technosphere	Not known
	Output	Residue	Waste water	1.13E+00			kg	Technosphere	Not known

About Inventory

Publication	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The aim of the study is to undertake an LCA of typical water and sewage pumps. Those aspects which have a major contribution to the environmental impact in the life cycle of a pump will be identified.''
Detailed Purpose	Limestone is needed to produce sinter which is the input for pig iron production. Pig iron is then processed into cast iron which is a main material in a water pump (90%).
Commissioner	Unknown - .
Practitioner	Johanna Thuresson - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Linoleum flooring. ESA-DBP

Administrative

Finished	Y
Date Completed	1994
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System

Name	Linoleum flooring. ESA-DBP
Functional Unit	1 m2*year flooring
Functional Unit Explanation	Excerpt from the publication (see 'Publication'): ''The purpose of the study was to assess and compare the environmental impact from cradle to grave for floor coverings. The covering of one square metre of flooring during one year of operation was therefore chosen as the functional unit, or basis of comparison.'' 1 m2 of linoleum floor weighs 2.556 kg, including laying waste.
Process Type	Cradle to grave
Site	Not applicable
Sector	Construction
Owner	Not applicable
Technical system description	Excerpt from the publication: ''The life cycle of linoleum. Linseed oil, which is the most important raw material in the actual linoleum paste, acts as a binder. The oil is catalytically oxidised and polymerised with air in large tanks. This produces linoxyn, a reddish-brown highly elastic mass. The hnoxyn is then mixed with resin from coniferous trees, known as colophonium. The mixed linoxyn and resin form a cement, which is left to mature. The cement is then mixed with powdered cork, powdered wood, powdered limestone and pigment. Powdered wood and cork are used to give the sheeting resiliance, and powdered limestone is used as a mineral filler. In linoleum, titanium dioxide is used as the main pigment. After the mixing process, a homogeneous linoleum mass is obtained, which is then converted into granules. The granules are fused to backing, made from jute, under pressure and heat. The still soft sheeting is hung up in long loops in drying rooms to mature further, and is left there for two to three weeks. As the last stage of manufacture the sheets are coated with a thin layer of acrylate. After this has been done, the sheeting is trimmed and rolled. and after packaging it is ready for sale. The production chain takes four to six weeks.'' The flow chart for linoleum flooring can be found at page 247 in the publication. This system is described in: Jönsson et al, 1997, Life cycle assessment of flooring materials: case study. Building and Environment, Vol. 32, No. 3, pp. 245-255. Link to pdf: http://cpmdatabase.cpm.chalmers.se/DataReferences/Joensson_et_al_1997.pdf Other processes in the CPM Database also included in the above publication: Vinyl flooring. ESA-DBP Solid wood flooring. ESA-DBP Other processes in the CPM Database connected to the above publication: Dioctyl phthalate (DOP) production. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	Data are applicable to the situation at the time, i.e. 1994.
Geographical Boundary	The scenarios describe a Swedish situation. The linoleum studied was produced in the Netherlands.

Other Boundaries	Excerpts from the publication (see 'Publication'): - Floorings for domestic use were studied. - It was assumed for the calculations that there is no recycling or recovery of the flooring materials, and that all materials are incinerated, with energy recovery, after use. - It was assumed that all pigments used consisted of titanium dioxide. - Some additives in the products were used in such small quantities that their environmental impact was disregarded in the study.
Allocations	Excerpt from the publication (see 'Publication'): ''The environmental impact of multi-output processes was allocated in proportion to the physical parameter most closely reflecting the economic value, which in most cases resulted in weight being used. No allocation was made between the two functions of incineration, waste elimination and heat production. Instead, the heat produced was reported as a useful energy flow leaving the systems analysed.''
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	Derived, mixed
Represents	See 'Function'.
Method	Excerpt from the publication (see 'Publication'): ''In this study, the necessary information was gathered from producing companies, authorities and the literature, including other LCA studies.''
Literature Reference	Jönsson et al, 1997, Life cycle assessment of flooring materials: case study. Building and Environment, Vol. 32, No. 3, pp. 245-255. Link to pdf: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/Joensson_et_al_1997.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Flax cultivation (fertiliser). Wood and linseed are included both as mass and as land use. This is in a sense double accounting, but for the impact assessment which follows it is beneficial that both parameters are presented.	Input	Natural resource	arable land	9.82			m2 year	Ground	
Notes: Tree cultivation. Wood and linseed are included both as mass and as land use. This is in a sense double accounting, but for the impact assessment which follows it is beneficial that both parameters are presented.	Input	Natural resource	Forest land	4.52			m2 year	Ground	
Notes: Linoleum production (raw material).	Input	Refined resource	acrylate	2.5			g	Technosphere	
	Input	Refined resource	Calorific value	45.2			MJ	Technosphere	
Notes: Linoleum production (raw material).	Input	Refined resource	cork	128			g	Technosphere	
Notes: Linoleum production (44 %). Titanium dioxide production (30 %).	Input	Refined resource	Electricity	16.3			MJ	Technosphere	
Notes: Linoleum production (67 %).	Input	Refined resource	Fossil fuel	25			MJ	Technosphere	
Notes: Linoleum production (raw material).	Input	Refined resource	hessian	280			g	Technosphere	
Notes: Flax cultivation (fertiliser).	Input	Refined resource	K2O	13.5			g	Technosphere	
Notes: Linoleum production (raw material).	Input	Refined resource	linseed	588			g	Technosphere	
Notes: Flax cultivation (fertiliser).	Input	Refined resource	P2O5	16.5			g	Technosphere	
Notes: Linoleum production (raw material).	Input	Refined resource	Resin	204			g	Technosphere	
Notes: Linoleum production (raw material).	Input	Refined resource	Titanium dioxide	102			g	Technosphere	
Notes: Linoleum production (raw material).	Input	Refined resource	Wood	767			g	Forestral ground	
Notes: Linoleum production (raw material).	Input	Resource	Limestone	460			g	Ground	

Notes: Incineration.	Output	By-product	Recovered energy	28.8			MJ	Technosphere	
Notes: Transports (80%).	Output	Emission	CO	1.06			kg	Air	
Notes: Linoleum production (58%).	Output	Emission	CO2	1.6			kg	Air	
Notes: Transports (65%). Emissions occurring at precombustion processes of fossil fuels (refining, etc.).	Output	Emission	COD	6.96			mg	Water	
Notes: Powdered limestone production (96%).	Output	Emission	Dust	34.5			g	Air	
Notes: Incineration (40%), Transports (31%), linoleum production (20%).	Output	Emission	NOx	12.8			g	Air	
Notes: Transports (65%). Emissions occurring at precombustion processes of fossil fuels (refining, etc.).	Output	Emission	N-tot	1.14			mg	Water	
Notes: Transports (65%). Emissions occurring at precombustion processes of fossil fuels (refining, etc.).	Output	Emission	Oil	2.38			mg	Water	
Notes: Transports (65%). Emissions occurring at precombustion processes of fossil fuels (refining, etc.).	Output	Emission	Phenol	0.034			mg	Water	
Notes: Transports (62%).	Output	Emission	SO2	4.3			g	Air	
Notes: Linoleum production	Output	Emission	Solvents	3.12			g	Air	
Notes: Powdered wood production.	Output	Emission	Terpenes	34.5			mg	Air	
Notes: Linoleum production (87%).	Output	Emission	VOC	5.87			mg	Air	
	Output	Product	Linoleum flooring	1			m2 year	Technosphere	
Notes: Incineration.	Output	Residue	Ash	555			g	Technosphere	
Notes: Titanium dioxide production.	Output	Residue	Hazardous waste	238			g	Technosphere	
Notes: Hessian production.	Output	Residue	sector-specific waste	17.2			g	Technosphere	

About Inventory

Publication	Jönsson et al, 1997, Life cycle assessment of flooring materials: case study. Building and Environment, Vol. 32, No. 3, pp. 245-255. Link to pdf: http://cpmdatabase.cpm.chalmers.se/DataReferences/Joensson_et_al_1997.pdf
Intended User	LCA practitioners.
General Purpose	Excerpts from the publication (see 'Publication'): ''The consequences of the human impact on the environment have become increasingly clear in recent years. A number of previously unknown environmental problems have emerged at local, regional and global levels, in spite of considerable efforts to decrease environmental emissions from identified point sources. Consequently, demands are now being made on the environmental soundness of products. From industry there is a demand for methods of improving products from the environmental point of view, both for internal use and for marketing purposes. Authorities need methods which can be used to assess the environmental consequences of product related decisions. Life cycle assessment (LCA) is becoming an increasingly important method for making product related environmental assessments.'' ''When applying LCA to building materials and components, special methodological problems arise because of the relatively long lifetime and the complex purpose of these products. Therefore, a project entitled ''Environmental Assessment of Buildings and Building Materials'' has been initiated at the Department of Technical Environmental Planning of Chalmers University of Technology (CTH). The case study of flooring materials presented in this article constitutes the first step in this project.''
Detailed Purpose	Excerpt from the publicatoin (see 'Publication'): ''The environmental impact of three flooring materials during their life cycles was assessed and compared using the LCA method. The objective was to make a specific comparison between the environmental impacts of the life cycle of some flooring materials and to develop a methodology for LCA of building materials.''
Commissioner	Not applicable - .
Practitioner	Jönsson, Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden .
Reviewer	Tillman, Anne-Marie - Environmental Systems Analysis
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.

About Data	Excerpts from the publication (see 'Publication'): '' - The three studied products all have a calorific value and could alternatively be used as fuels. Since the energy recovered from incineration was accounted for as an energy gain, the calorific value of the materials was treated as an energy cost. - Production of electricity was not included in the systems analysed, due to lack of data. Electricity use was thus accounted for only as the amount used. When interpreting the results, the amount of electricity used reflects a number of environmental impacts, including flooded land from hydropower, radioactive waste from nuclear power and emissions to the air from fossil fuel based electricity production. - The environmental impact of cleaning and maintenance was omitted. It was roughly assumed that the cleaning habits are probably independent of what floor covering is used. In addition, no reliable data were available in this area.'' ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-09-15 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Liquid crystal display unit assembly

Administrative	
Finished	Y
Date Completed	2000-03-01
Copyright	Ericsson
Availability	Official

Technical System	
Name	Liquid crystal display unit assembly
Functional Unit	One gram liquid crystal display unit
Functional Unit Explanation	The motivation for choosing this functional unit is: · suitable unit to work with in an LCA of a private branch exchange (a complicated telecom product) · important component of the MD110 product system and many other electronic products. DESIGN Both answers from component manufacturer one (CM1) and component manufacturer two (CM2) are for exactly the same component. These facts are based on Ericsson technical specification of the component. Ericsson product number: RNH 921 409/1 Ericsson description of the display unit: Liquid Crystal Display Module General Display: 40 characters x 3 lines Liquid Crystal Display module Character font: 5x8 dot matrix Technology: FSTN (Film SuperTwisted Nematic) Mode: positive, operates in reflective mode Viewing angle 6 O'clock viewing angle direction Duty cycle: 1:32 Bias: 1:6.7 Interface: 4-bit MPU interface Antiglare: yes Flat cable: yes

	DESIGN RNH 921 409/1 is a display module completed with larger line distance, with driving circuits which are mounted on its PC board. The display module is provided with a flat cable. Height: 38,8 mm Width: 164,4 mm Lenght: 9,5 mm Weight: 72 gram per display according to Ericsson Weight CM1: 76,2 g (106,2 g including packaging material) Weight CM1: 56,9 g
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of a liquid crystal display unit. The activity is an average based on information acquired from two manufacturers. The description of the process is supplied by manufacturer one, but is assumed to be general for this type of manufacture. The following process steps are included; 1. Mother glass patterning 2. Off-set printing: 3. Rubbing 4. Common & seal printing 5. Mother glass assembly 6. Scribing & breaking 7. Liquid crystal injection 8. End seal 9. Cell inspection 10. Polarizer cut & attachment 11. LCD inspection 12. Module assembly with PCB 13. Inspection & packing 14. QA shipment inspection 15. Consignment Details given: 1. Mother glass patterning: The patterning of the mother glass is done through a mask that reproduce the drawing of circuit. 2. Off-set printing: The alignment layer is printed over the mother glass 3. Rubbing: The system uses an high speed rotary roll. 4. Common & seal printing: By a screen printing process the common & seal agent are coated. 5. Mother glass assembly: Front & rear glasses are aligned to dedicated mark patterns. 6. Scribing & breaking: Glass is scribed along separation lines by small roll cutter and broken apart along the scribed lines. 7. Liquid crystal injection: Every cell is filled with liquid crystal (LC) in a vacuum chamber. 8. End seal: The filling hole is covered by an agent. 9. Cell inspection: Appearance & functional tests are carried out. 10. Polarizer cut & attachment: Front & rear polarizers are cut and attached to the cell. 11. LCD inspection: Appearance & functional tests are carried out. 12. Module assembly with PCB: LCD is assembled with frame, PCB and rubber connectors. 13. Inspection & packing: Products are inserted in plastic bags and included in inner boxes. 14. QA shipment inspection: Further tests are carried out. 15. Consignment: Products are packed inside master carton and shipped accordingly. Manufacturer two did not give any information about process steps. Additional information from manufacturer one (CM1): The annual production of liquid crystal display units is 180 000 pieces. A module is composed by the glass display and the electronic driving board assembled with a metal frame. More than 70% of the organic thinners (acetone and other ketones and alcohols) are

	recovered at the liquid state and wasted by an authorized service supplier. The recovery inside the factory is included by this supplier in the activity. The process water containing acid, salt and hydroxides are treated in a specific facility before sent into a river. The wastewater treatment are not included in the activity. There are two energy sources involved. The electric energy is used to run the machines and for the process ovens. The natural gas is used for the air conditioning and heating system. The concentration of the organic solvent in the air exhaust is periodically checked in the pipes by the Government Control Service. The quality of the wastewater is periodically checked the Government Control Service.

System Boundaries

Nature Boundary	The emissions to air have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impact has been studied. Included component manufacturers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used. Emissions to water are stated before the wastewater treatment facility.
Time Boundary	1998 The answer from the manufacturer arrived in 1998 and they measured in 1998. The process technology used is most certainly the best available as the factories are located in Italy and Japan and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturers included in the average are located in Italy and Japan.
Other Boundaries	Delimitations to the system is the final step in the making of the display unit. The production of the subparts (e.g. polarizer film, gold plated board, and liquid crystal) of the display unit is not included in this model The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability. For component manufacturer one, the packaging materials for the incoming raw material have been included.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The data that are presented are calculated as a average based on information from two component manufacturers. The information from the manufacturers was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers In the information supplied by the manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+..+.ACn Step 2: The sum AC11+..+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to two answers was made.
Literature Reference	
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 460 mg from CM1. 0,46 g / 106,2093 g = 4,33e-3 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer.	Input	Refined resource	Acetone	0.00433			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,005 g /106,2093 g = 0,000047 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Ag	0.000047			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 30 g /106,2093 g = 0,282 g/g (Carton pack) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Cardboard	0.282			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Calculated and estimated 0,07 m3 from CM1. 0,07 m3 * 0,72 kg/m3 /106,2093/1000 = 4,745e-7 g/g display unit. 0,07/106,2093*39,89 = 0,0262905414121 MJ/g display unit. Brohammer, Produktekologi, ISBN 91-27-72174-4, (1998) page 116: Higher heating value for methane: 39,89 MJ/m3 106,2093 g is the weight of one display unit according to this manufacturer. 0,72 kg/m3 is the density of methane at NTP according to formelsamlingen page 71. This is not an average value and the figure is based only on one answer. Literature: Brohammer, Produktekologi, ISBN 91-27-72174-4, (1998) page 116:	Input	Refined resource	CH4	2.629054E-02			MJ	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0,7 mg/56987,6 mg = 0,0000123 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Coating material	0.0000123			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 5,5 g /106,2093 g = 0,0518 g/g CM2: 2870 mg/56987,6 mg = 0,0503 g/g (Stated as resistor, condenser + Flat cable) (CM1+CM2)/2 = 0,051 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Electrical components + flat cable	0.051			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Calculated and estimated 0,95 kWh from one manufacturer. 950 Wh/106,2093 g = 8,944602779606 Wh/g display unit Calculated and estimated 1,8 kWh from an other manufacturer. 1800 Wh/56,9876 g = 31,58581866932 Wh/g display unit. Value used in this LCI model: (8,944602779606 + 31,58581866932)/2 = 20,26521072447 Wh/g display unit. The used value is 20,265 Wh/g display unit. This is an average value and the figure is based on two answers.	Input	Refined resource	Electricity	20.26521			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,02 g /106,2093 g = 0,000188 g/g (Epoxy sealant) CM2: 9,7 mg/56987,6 mg = 0,00017 g/g (Sealing material) (CM1+CM2)/2 =	Input	Refined resource	Epoxy	0.00018			g	Technosphere	

0,00018 g/g This is an average value and the figure is based on two answers.									
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 130 mg from one manufacturer. 0,13 g / 106,2093 g = 1,224e-3 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based on one answer. Notes: 64-17-5 is the CAS number for Ethyl alcohol	Input	Refined resource	Ethyl Alcohol	0.001224			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 5,5 g from one manufacturer. 5,5 g / 106,2093 g = 5,178e-2 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer. Notes: 7705-08-0 is the CAS number for ferric chloride	Input	Refined resource	ferric chloride	0.0000517			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 60 g /106,2093 g = 0,565 g/g CM2: 11657 mg/56987,6 mg = 0,205 g/g (CM1+CM2)/2 = 0,385 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Glass	0.269			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,003 g /106,2093 g = 0,000282 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Glass fibre	0.0000282			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 22 g /106,2093 g = 0,207 g/g CM2: 18920 mg/56987,6 mg = 0,332 g/g (given as PCB, printed circuit board) (CM1+CM2)/2 = 0,269 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Gold plated board	0.269			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 5,5 g from one manufacturer. 5,5 g / 106,2093 g = 5,178e-2 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. Estimated 1,7 mg from one manufacturer. 0,0017 g / 56,9876 g = 2,983105096547e-5 g/g display unit. 56,9876 is the weight of one display unit according to this manufacturer. Average value: (5,178 e-2 + 2,983e-5)/2 = 0,025864915 g/g display unit. This is an average value and the figure is based on two answers.	Input	Refined resource	Hydrochloric acid	0.025864			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 10 g from one manufacturer. 10 g / 106,2093 g = 0,09415 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer.	Input	Refined resource	Isopropanol	0.139			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Calculated and estimated 40 ml from CM2. 40 cm3 * 0,89 g/cm3 /56,9876/1000 = 6,247e-4 g/g display unit. 6,247e-4 g * 45 MJ/kg = 0,0281115 MJ/g display	Input	Refined resource	Kerosene	0.0281115			MJ	Technosphere	

unit. 56,9876 g is the weight of one display unit according to this manufacturer. 0,89 kg/m3 is the density of kerosene at NTP according to formelsamlingen page 71. Brohammer page 116, HHV oil: 45 MJ/kg This is not an average value and the figure is based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,03 g /106,2093 g = 0.000282 g/g CM2: 250 mg/56987,6 mg = 0,00439 g/g (Stated as resistor, condenser + Flat cable) (CM1+CM2)/2 = 0,002336 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Liquid crystal polymer (LCP)	0.002336			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 40 mg from one manufacturer. 0,04 g / 106,2093 g = 3,766e-4 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer.	Input	Refined resource	Methyl isobutyl ketone	0.0003766			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 18,8 dm3 from CM2. Density nitrogen (liquid) from Tabell- och formelsamlingen för gymnasieskolan (1988), ISBN 91-7548-544-3, page 71 = 1,25 kg/m3 18,8 e-3 m3 * 1,25 kg/m3 /1000/56,9876 = 4,123704104051e-7 g N2/g display unit. 56,9876 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer. Literature: Tabell- och formelsamlingen för gymnasieskolan (1988), ISBN 91-7548-544-3	Input	Refined resource	N2	4.123704E-07			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 1000 mg NaOH and KOH from one manufacturer. 0,5 * 1 g / 106,2093 g = 4,7e-3 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. Assumed 50 % KOH and 50 % NaOH This is not an average value and the figure is based only on one answer. Literature: n.a. Notes: n.a.	Input	Refined resource	NaOH	0.0047			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 4500 mg paper from one manufacture and the same manufacturer has measured the use of Carton pack to 30 000 mg. 4,5 g / 106,2093 g = 0,04236917106129 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer. Literature: n.a. Notes: n.a.	Input	Refined resource	Paper	0.0424			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 320 mg from one manufacturer. 0,32 g/106,2093 g Measured 70 mg from an other manufacturer. 0,07 g/56,9876 g Value used in this LCI model: (0,32 g/106,2093 g + 0,07 g/56,9876 g)/2 = 0,002120628111848 g/g display unit. This is an average value	Input	Refined resource	Photoresist	0.00212			g	Technosphere	

and the figure is based on two answers.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 3.5 g /106,2093 g = 0,033 g/g CM2: 2868 mg/56987,6 mg = 0,0503 g/g (stated as Polarizers) (CM1+CM2)/2 = 0,0416 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Polarizer film	0.0416			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,0025 g /106,2093 g = 0,000235 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polyamides	0.0000235			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 3.5 g /106,2093 g = 0,033 g/g (PE antistatic bag) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polyethylene	0.033			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,05 g /106,2093 g = 0,00047 g/g (Polimide ink) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polyimide	0.00047			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,003 g /106,2093 g = 0,0000282 g/g (Metacrylate sealant) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polymethyl Methacrylate	0.0000282			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 1000 mg NaOH and KOH from one manufacturer. 0,5 * 1 g / 106,2093 g = 4,7e-3 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. Assumed 50 % KOH and 50 % NaOH This is not an average value and the figure is based only on one answer.	Input	Refined resource	Potassium hydroxide	0.0047			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 2,2 g /106,2093 g = 0,0207 g/g CM2: 3360 mg/56987,6 mg = 0,059 g/g (given as Zebra rubber connector) (CM1+CM2)/2 = 0,0398 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Silicone Rubber	0.0398			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,9 g /106,2093 g = 0,00847 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Sn	0.00847			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Calculated and estimated 2780 mg from one manufacturer. 2,78 g / 56,9876 g = 0,04878 g/g display unit. 56,9876 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer.	Input	Refined resource	Solder cream	0.04878			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 14,2 g /106,2093 g = 0,134 g/g CM2: 19050 mg/56987,6 mg = 0,334 g/g (stated as metal holder) (CM1+CM2)/2 = 0,234 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Stainless steel	0.234			g	Technosphere	

Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 130 mg from one manufacturer. 0,13 g / 106,2093 g = 0,001223998275104 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. Used value: 0,00122 g/g display unit. This is not an average value and the figure is based only on one answer.	Input	Refined resource	Velvet	0.00122			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 200 mg from one manufacturer. 0,2 g / 106,2093 g = 1,883e-3 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer.	Output	Emission	Acetone	0.001883			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Calculated and estimated 0,77 ml from one manufacturer. 0,77 cm3 * 1,98 g/cm3 /56,9876/1000 = 2,676-5 g/g display unit. 56,9876 g is the weight of one display unit according to this manufacturer. 1,98 kg/m3 is the density of CO2 at NTP. This is not an average value and the figure is based only on one answer.	Output	Emission	CO2	2.676E-05			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 60 mg from one manufacturer. 0,06 g / 106,2093 g = 5,649 e-4 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer.	Output	Emission	Ethyl Alcohol	0.0005649			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 5,5 g from one manufacturer. 5,5 g / 106,2093 g = 5,178e-2 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer. Notes: CM1: The data is related to the situation before the treatement water facility.	Output	Emission	ferric chloride	0.0517			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 5,5 g from one manufacturer. 5,5 g / 106,2093 g = 5,178e-2 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer. Notes: CM1: The data is related to the situation before the treatement water facility.	Output	Emission	Hydrochloric acid	0.0517			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 400 mg from one manufacturer. 0,4 g / 106,2093 g = 3,766e-3 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer. Notes: i-Propanol is the same as Isopropanol	Output	Emission	i-Propanol	0.003766			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 15 mg from one manufacturer. 0,0055 g / 106,2093 g = 1,412e-4 g/g 106,2093 g is the	Output	Emission	Methyl isobutyl ketone	0.0001412			g	Air	

weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 26,4 g from one manufacturer. 26,4 g / 56,9876 g = 0,463 g/g display unit. 56,9876 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer.	Output	Emission	N2	0.463			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 1000 mg NaOH and KOH from one manufacturer. 0,5 * 1 g / 106,2093 g = 4,7e-3 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. Assumed 50 % KOH and 50 % NaOH This is not an average value and the figure is based only on one answer. Notes: CM1: The data is related to the situation before the treatement water facility.	Output	Emission	NaOH	0.0047			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 190 mg from one manufacturer. 0,19 g / 106,2093 g = 1,788e-3 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer.	Output	Emission	Photoresist	0.001789			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 1000 mg NaOH and KOH from one manufacturer. 0,5 * 1 g / 106,2093 g = 4,7e-3 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. Assumed 50 % KOH and 50 % NaOH This is not an average value and the figure is based only on one answer. Notes: 1310-58-3 is the CAS-number for KOH CM1: The data is related to the situation before the treatement water facility.	Output	Emission	Potassium hydroxide	0.0047			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: 1 gram display unit output is the base for all figures in this model.	Output	Product	Display units	1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Own calculation: Acetone input - Acetone in product output - Acetone as emissions = Acetone waste output = 0,00433 - 0 - 0,001883 = 0,002447 g/g display unit This is not an average value and the figure is based only on one answer.	Output	Residue	Acetone	0.002447			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 7.42 mg/56987,6 mg = 0,00013 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Epoxy	0.00013			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 30 g /106,2093 g = 0,282 g/g (Recycled to 100 %) CM2: 583 mg/56987,6 mg = 0,01 g/g (Recycled 2950 mg) (CM1+CM2)/2 = 0,146 g/g This is an average value and the figure is based on two answers.	Output	Residue	Glass	0.146			g	Technosphere	

Date concieved: 1998 Data type: Derived, unspecified Method: Own calculation: Isopropanol input - Isopropanol product output - Isopropanol as emissions = Isopropanol waste output = 0,139 - 0 -0,003766 = 0,135234 g/g display unit This is not an average value and the figure is based only on one answer.	Output	Residue	Isopropanol	0.135234			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 199,6 mg/56987,6 mg = 0,0035 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Liquid crystal polymer (LCP)	0.0035			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Own calculation: Methyl isobutyl ketone input - Methyl isobutyl ketone in product output - Methyl isobutyl ketone as emissions = Methyl isobutyl ketone as waste output = 0,0003766 - 0 -0,0001412 = 0,0002354 g/g display unit This is not an average value and the figure is based only on one answer.	Output	Residue	Methyl isobutyl ketone	0.0002354			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Own calculation: Paper input - Paper in product output - Paper as emissions = Paper waste output = 0,0424 - 0 -0 = 0,0424 g/g display unit This is not an average value and the figure is based only on one answer.	Output	Residue	Paper	0.0424			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 1803 mg/56987,6 mg = 0,032 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Polarizer film	0.032			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: This flow is by one of the manufacturers called ''water treatment mud''. I called it Sludge. Estimated 20000 mg from one manufacturer. 20 g / 106,2093 g = 0,1883074269391 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. This is not an average value and the figure is based only on one answer.	Output	Residue	Sludge	0.1883			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Calculated and estimated from one manufacturer. (2,780 - 2,140)/56,9876 = 0,01123051330465 g Solder cream/g display unit. 56,9876 g is the weight of one display unit according to this manufacturer. 2140 mg is the amount solder paste in product output. 2780 mg is the amount solder paste in raw material input. I assume the rest is waste output. This is not an average value and the figure is based only on one answer.	Output	Residue	Solder cream	0.0112			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Estimated 20000 mg from one manufacturer. 20 g / 106,2093 g = 0,1883074269391 g/g display unit. 106,2093 g is the weight of one display unit according to this manufacturer. Used value: 0,1883 g/g display unit. This is not an average value and the figure is based only on one answer.	Output	Residue	Waste water treatment chemicals	0.1883			g	Technosphere	

About Inventory	
Publication	Not available. --- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a display unit manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of display units and resembling components in our telecom products. The usage for this set of data are life cycle assessments where display units are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. --- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly

	11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to display units in electronic equipment if you know how much the display units weigh. The model is also intended to be representative for indicators in electronic equipment. -- Transports.-- Here follows a more detailed description of transports of materials and components to the respective manufacturer factories. These transports are not included in the model. The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport. -- Truck transportation: -- Component manufacturer one (CM1): Glass with weight 30 g is transported 250 km, i.e. 30 g*250 km, Polaricer film 2 g * 250 km, Gold plated board 18 g * 30 km, Stainless steel 14,2 g * 30 km, Silicone rubber 2,2 g * 250 km, El. components 5,5 g * 300 km, PE anti static Bag 3,5 g * 50 km, Carton pack 30 g * 50 km, that is 12841 gkm. Weight of component: 106.2093 g The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 12841 gkm/106.2093 g = 120.90 gkm/g Component manufacturer two (CM2): Weight of component: 56.9876 g Glass with weight 11.657 g is transported 400 km by road i.e. 11.657 g*400 km, Liquid crystal 0.25 g*850 km, Polarizers 2.868 g*600 km, Sealing material 0.0097 g*950 km, Coating materials 0.0007 g*450 km, PCB 18.92 g*350 km, LCD driver 4.02 g*800 km, Metal holder 19.05 g*800 km, Zebra rubber connector 3.36 g*600 km, Flat cable 2.8 g*800 km, Resistor, capacitor 0.07 g*800 km and Solder paste 2.78 g*480 km The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 35781.31 gkm/56.9876 g = 627.88 gkm/g This gives the average total transportation work by truck for CM1 and CM2: (CM1+CM2)/2= 374.39 gkm/g --Airplane transportation: -- Calculations manufacturer one: 2 grams of polarizer transported 10000 km to the factory 2,2 grams of silicon rubber 10000 km to the factory 5,5 grams of electronic components 10000 km to the factory that is 97000 gkm. 97000 gkm/106,2093 g = 913,29gkm / g display unit

	-- Boat transportation: -- Calculations manufacturer one: Transport by boat: 30 grams of glass transported 18000 km to the factory that is 54000 gkm. 54000 gkm/106,2093 g = 508,43 gkm / g display unit
About Data	The data is based on information from one Italian and one Japanese manufacturer. The information was gathered using a life cycle inventory questionnaire. All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model. Of the flows about little more than 79 % are not average values. The flows for Raw material input of Glass, Polarzer film, Photoresist, HCl, Gold plated board, Stainless steel, Electrical components, Liquid crystal polymer and Epoxy resin, Waste output of Glass and Energy input of Electricity are average values. In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included. The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. The result is that approximately 22 % of the flows used in all manufacturers answers were only calculated, 10 % were only estimated, 18 % were only measured and 37 % were first estimated and then calculated. 13 % were first measured and then calculated The outline of the LCI data questionnaire that were used in the inventory follows below. No limitations or specifications were set for which substances they had to account -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes.´ Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gatherd it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil.

	Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Locomotive two-stroke engine

Administrative	
Finished	Y
Date Completed	1996-04-01
Copyright	
Availability	Public

Technical System	
Name	Locomotive two-stroke engine
Functional Unit	1 kWh
Functional Unit Explanation	1 kWh mechanical work done by the engine
Process Type	Unit operation
Site	Sweden
Sector	Machinery and equipment
Owner	Sweden
Technical system description	Operation of a locomotive two-stroke engine.

System Boundaries	
Nature Boundary	Regulated emissions to air are considered.
Time Boundary	The data represents existing engines in use in 1996
Geographical Boundary	The data is based on an engine in use in Sweden.
Other Boundaries	A standardised test cycle on the engine (ECE R49) was used.
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1996-01-01
Data Type	Single sample
Represents	See 'Function'.
Method	The emissions were obtained by tests on one locomotive engine using the standardised test cycle ECE R49 (MTC 96:4). The fuel used in the tests was diesel environmental class 3. The tests give weighted emission index in g/kWh, where kWh refer to mechanical work done by the engine.
Literature Reference	Exhaust emissions from a two stroke locomotive engine, MTC rapport 96:4, Motortestcenter, Svensk Bilprovning, 1996
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Diesel environmental class 3	237			g	Technosphere	
	Output	Emission	CO	1.27			g	Air	
	Output	Emission	CO2	751			g	Air	
	Output	Emission	HC	0.77			g	Air	
	Output	Emission	NOx	19.4			g	Air	
	Output	Emission	SO2	0.1			g	Air	
	Output	Product	Mechanical work	1			kWh	Technosphere	

About Inventory

Publication	Exhaust emissions from a two stroke locomotive engine, MTC rapport 96:4, Motortestcenter, Svensk Bilprovning, 1996 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	
General Purpose	
Detailed Purpose	To obtain a basis to calculate emissions for diesel driven locomotive engines
Commissioner	- Swedish State Railways.
Practitioner	- Motortestcenter, Box 223, S-136 23 Haninge, Sweden .
Reviewer	
Applicability	
About Data	
Notes	The data was used as a basis to calculate the energy use and emissions from dieseldriven train traffic in the work of NGM published in Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997, NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997

SPINE LCI dataset: Luxembourg, electricity generation mix 1998

Administrative

Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System

Name	Luxembourg, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Luxembourg
Sector	Energyware
Owner	Luxembourg

Technical system description	The generation of electricity with different power generating systems in Luxembourg during the year 1998.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The emissions were obtained by tests on one locomotive engine using the standardised test cycle ECE R49 (MTC 96:4). The fuel used in the tests was diesel environmental class 3. The tests give weighted emission index in g/kWh, where kWh refer to mechanical work done by the engine.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See "Represents" for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	115			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	204			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	45			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	5			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	369			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by:

	Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

Administrative	
Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Maintenance of train bearings - train type 'Regina'. ESA-DBP
Functional Unit	2 axleboxes with bearings on a distance of 100 000km
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. The functional unit (fu) is here defined as 2 axleboxes with bearings, mounted on a wheel axle in use on its matched Electric Multiple Unit (EMU) during 100 000 km of transport. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year.''
Process Type	Gate to gate
Site	SKF Sverige AB 415 50 Göteborg
Sector	Land transport
Owner	SKF Sverige AB 415 50 Göteborg
Technical system description	The study was done for a a train 'Regina' which is manufactured by Adtranz, today Bombardier Transportation, since the year 2000. In this kind of train pre-lubricated, sealed Tapered Bearing Units, so-called TBUs are used. The Reginas are used on the Swedish West coast, in Mälardalen and in Bergslagen. Excerpt from the study, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. (...) The Regina TBU is named 1639605 C and contains the bearing BT2B 641157 CB. The axlebox has the number 432758. The maintenance interval is of great importance for the analysis of the total environmental impact from the use of train bearings. However, the real maintenance interval is difficult to estimate, as the wheel axles can be sent to refurbishment for various reasons, e.g. misuse, derailment, warm-running, reached recommended maintenance interval etc. There is no statistics on how often the bearings are sent to refurbishment just because of malfunction of the bearings themselves. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year. For the bearings in Regina (...) the recommended maintenance interval (...) is 1 000 000 km. (...) These figures are based on evaluations of many factors, like climate, speed, lubrication and wheel axle and bearing construction, and do not reflect the performance of the bearings alone. (...) For the maintenance process, there is a number of sub-processes called dismounting of wheel axle, detergent production, naphtha production, lubricating oil and grease production, local processes, and waste oil handling.'' This process is included in the system described in: Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf Other processes in the CPM Database also included in the above publication: - Operation on train bearings - train type 'X1'. ESA-DBP - Operation on train bearings - train type 'X10'. ESA-DBP - Operation on train bearings - train type 'Regina'. ESA-DBP - Maintenance of train bearings - train type 'X1'. ESA-DBP - Maintenance of train bearings - train type 'X10'. ESA-DBP - Use phase of train bearings - train type 'X1'. ESA-DBP - Use phase of train bearings - train type 'X10'. ESA-DBP - Use phase of train bearings - train type 'Regina'. ESA-DBP

System Boundaries	
Nature Boundary	The emissions to air and water are considered.

Time Boundary	Excerpt from the report, see 'Publication': ''The study is intended to illustrate the present situation, and the qualitative and quantitative information for the main processes are from the year 2001 until today. (NB: the report was written in 2003)
Geographical Boundary	Sweden
Other Boundaries	Excerpt from the report, see 'Publication': ''The environmental effects of industrial buildings, production of tools and machines, and the use of human labour are not included. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2001
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The data for dismounting and refurbishment were taken from the sites where the process takes place. Data for detergent, oil and transport were take from existing databases.
Literature Reference	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2003--3.pdf
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity (accounted)	2.23E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity (non-accounted)	7.29E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Feedstock energy	1.04E+01			MJ	Technosphere	Sweden
	Output	Emission	Acid H+	1.04E-02			g	Water	Sweden
	Output	Emission	Al	1.19E-03			g	Water	Sweden
	Output	Emission	Aluminium sulphate	7.66E-03			g	Water	Sweden
	Output	Emission	AOX as Cl-	2.45E-05			g	Water	Sweden
	Output	Emission	Aromatic HC	1.14E-04			g	Air	Sweden
	Output	Emission	Aromatic HC	4.25E-04			g	Water	Sweden
	Output	Emission	Arsenic	2.52E-06			g	Water	Sweden
	Output	Emission	Arsenic	3.72E-08			g	Air	Sweden
	Output	Emission	Assay Al2O3	4.37E-03			g	Water	Sweden
	Output	Emission	Ba	5.16E-04			g	Water	Sweden
	Output	Emission	Be	4.65E-10			g	Air	Sweden
	Output	Emission	Benzene	8.01E-05			g	Air	Sweden
	Output	Emission	BOD	4.47E-03			g	Water	Sweden
	Output	Emission	Cd	2.43E-06			g	Air	Sweden
	Output	Emission	Cd	4.65E-05			g	Water	Sweden
	Output	Emission	CH4	3.94E-01			g	Air	Sweden
	Output	Emission	Chlorinated CH	1.97E-07			g	Water	Sweden
	Output	Emission	Cl-	9.54E+00			g	Water	Sweden
	Output	Emission	CN-	6.72E-07			g	Water	Sweden
	Output	Emission	CO	2.61E-01			g	Air	Sweden
	Output	Emission	Co	4.65E-09			g	Water	Sweden
	Output	Emission	CO2	1.91E+02			g	Air	Sweden
	Output	Emission	COD	2.07E-01			g	Water	Sweden
	Output	Emission	Cr	3.25E-08			g	Air	Sweden
	Output	Emission	Cr	3.82E-05			g	Water	Sweden
	Output	Emission	Cu	1.30E-07			g	Air	Sweden
	Output	Emission	Cu	6.21E-06			g	Water	Sweden
	Output	Emission	Dimethyl-aminoacrylate	6.53E-03			g	Water	Sweden
	Output	Emission	Dioxin	4.65E-13			g	Water	Sweden
	Output	Emission	Dioxin	6.65E-15			g	Air	Sweden

	Output	Emission	Dissolved solids	6.63E-04			g	Water	Sweden
	Output	Emission	DOC	4.87E-05			g	Water	Sweden
	Output	Emission	Dust	2.44E-01			g	Air	Sweden
	Output	Emission	F-	8.13E-01			g	Water	Sweden
	Output	Emission	Fat	6.01E-03			g	Water	Sweden
	Output	Emission	Fe	5.88E-02			g	Water	Sweden
	Output	Emission	H2SO4	1.07E-02			g	Water	Sweden
	Output	Emission	Halogenated HC	1.11E-09			g	Air	Sweden
	Output	Emission	Halon H1301	8.02E-07			g	Air	Sweden
	Output	Emission	HC	4.56E-03			g	Water	Sweden
	Output	Emission	HCl	5.13E-03			g	Air	Sweden
	Output	Emission	HCl	6.74E-03			g	Water	Sweden
	Output	Emission	HF	8.08E-05			g	Air	Sweden
	Output	Emission	Hg	1.34E-08			g	Water	Sweden
	Output	Emission	Hg	3.79E-07			g	Air	Sweden
	Output	Emission	HNO3	2.68E-03			g	Water	Sweden
	Output	Emission	Inorganic salts and acids	4.19E+00			g	Water	Sweden
	Output	Emission	Metals	3.41E-03			g	Water	Sweden
	Output	Emission	Metals	7.92E-04			g	Air	Sweden
	Output	Emission	Mn	6.75E-07			g	Air	Sweden
	Output	Emission	N2O	5.48E-03			g	Air	Sweden
	Output	Emission	NaOH	1.44E-02			g	Water	Sweden
	Output	Emission	NH3	7.34E-03			g	Air	Sweden
	Output	Emission	NH4+	3.27E-03			g	Water	Sweden
	Output	Emission	Ni	1.75E-04			g	Water	Sweden
	Output	Emission	Ni	6.01E-05			g	Air	Sweden
	Output	Emission	Nitrogen organic bound	2.44E-05			g	Water	Sweden
Notes: non methane HC	Output	Emission	NMVOC non-methane HC	8.26E-01			g	Air	Sweden
	Output	Emission	NO2	1.02E+00			g	Air	Sweden
	Output	Emission	NO3-	3.54E-04			g	Water	Sweden
	Output	Emission	NTA solution (100%)	1.29E-04			g	Water	Sweden
	Output	Emission	N-tot	4.27E-04			g	Water	Sweden
	Output	Emission	PAH policycl. Arom. HC	2.19E-06			g	Water	Sweden
	Output	Emission	PAH policycl. Arom. HC	8.62E-02			g	Air	Sweden
	Output	Emission	Pb	5.16E-06			g	Water	Sweden
	Output	Emission	Pb	6.92E-06			g	Air	Sweden
	Output	Emission	Phenol	2.66E-04			g	Water	Sweden
	Output	Emission	PO43-	8.06E-05			g	Water	Sweden
	Output	Emission	Potasium hydroxite (KOH)	1.51E-03			g	Water	Sweden
	Output	Emission	Radioactive	3.69E+00			g	Air	Sweden
	Output	Emission	Radioactive emissions	3.41E-02			g	Water	Sweden
	Output	Emission	S2-	7.63E-05			g	Water	Sweden
	Output	Emission	Silicates	1.09E-02			g	Water	Sweden
	Output	Emission	SO2	9.34E-01			g	Air	Sweden
	Output	Emission	SO4 2-	7.17E-02			g	Water	Sweden
	Output	Emission	Sodium gluconate	3.70E-04			g	Water	Sweden
	Output	Emission	Sodium hypochlorite	3.73E-04			g	Water	Sweden
	Output	Emission	Sodium ions	5.43E-02			g	Water	Sweden
	Output	Emission	Sodium kapryl-aminodipropionate	8.40E-04			g	Water	Sweden
	Output	Emission	Suspended solids	3.29E+01			g	Water	Sweden
	Output	Emission	TEX (aliphatic)	1.84E-03			g	Water	Sweden
	Output	Emission	TOC	4.64E-03			g	Water	Sweden
	Output	Emission	Toluene	2.04E-05			g	Water	Sweden
	Output	Emission	Tridecylalkoholetoxilat	8.40E-04			g	Water	Sweden
	Output	Emission	Zn	7.48E-04			g	Water	Sweden
	Output	Emission	Zn	9.72E-06			g	Air	Sweden
	Output	Residue	Solid waste	1.05E-01			kg	Technosphere	Sweden
	Output	Residue	Waste water	6.68E+00			m3	Technosphere	Sweden

About Inventory

Publication	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF:

	http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this LCA is to investigate the environmental impact of the use-phase for bearings in trains. Three generations of trains, so-called Electrical Multiple Units (EMUs), will be studied, and comparison will be made between processes within the life cycle of the bearings, and between the bearings in the different generations of EMUs.''
Detailed Purpose	Maintenance of the bearings has a great importance in a use phase so it was necessary to investigate its impact.
Commissioner	SKF Sverige AB - 415 50 Göteborg .
Practitioner	Karl Jonasson - .
Reviewer	Björn Andersson, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report, see 'Publication': ''SKF provides both bearings and bearing housings for trains, called axleboxes, which are mounted in direct connection with the train's wheels to make the wheel axle able to rotate (...). The bearings used for this purpose are in this study referred to as 'train bearings', even though there are other fields of application for bearings in trains (e.g. in the traction system). What type of rolling bearings used for the wheel axle varies according to performance needs and train design, but the function is essentially the same.''

SPINE LCI dataset: Maintenance of train bearings - train type 'X1'. ESA-DBP

Administrative	
Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Maintenance of train bearings - train type 'X1'. ESA-DBP
Functional Unit	2 axleboxes with bearings on a distance of 100 000km
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. The functional unit (fu) is here defined as 2 axleboxes with bearings, mounted on a wheel axle in use on its matched Electric Multiple Unit (EMU) during 100 000 km of transport. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year.''
Process Type	Gate to gate
Site	SKF Sverige AB 415 50 Göteborg
Sector	Land transport
Owner	SKF Sverige AB 415 50 Göteborg

Technical system description	The study was done for a a train 'X1' which was manufactured by ASEA during the years 1967-1975. In this kind of train an un-sealed Spherical Roller Bearings (SRBs) were used. More than 100 of X1s were produced and most of them are still in use especially in Stokholm area. Excerpt from the study, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. (...) The SRB used in X1-A, X1-B and X10 has the SKF product number 23226 CC/C3W33, and the axleboxes are called 723724, 723721 and 4000850 respectively. The maintenance interval is of great importance for the analysis of the total environmental impact from the use of train bearings. However, the real maintenance interval is difficult to estimate, as the wheel axles can be sent to refurbishment for various reasons, e.g. misuse, derailment, warm-running, reached recommended maintenance interval etc. There is no statistics on how often the bearings are sent to refurbishment just because of malfunction of the bearings themselves. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year. For the bearings in X1 (...) the recommended maintenance interval (...) is 1 200 000 km. (...) These figures are based on evaluations of many factors, like climate, speed, lubrication and wheel axle and bearing construction, and do not reflect the performance of the bearings alone. (...) For the maintenance process, there is a number of sub-processes called dismounting of wheel axle, detergent production, naphtha production, lubricating oil and grease production, local processes, and waste oil handling.'' This process is included in the system described in: Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf Other processes in the CPM Database also included in the above publication: - Operation on train bearings - train type 'X1'. ESA-DBP - Operation on train bearings - train type 'X10'. ESA-DBP - Operation on train bearings - train type 'Regina'. ESA-DBP - Maintenance of train bearings - train type 'X10'. ESA-DBP - Maintenance of train bearings - train type 'Regina'. ESA-DBP - Use phase of train bearings - train type 'X1'. ESA-DBP - Use phase of train bearings - train type 'X10'. ESA-DBP - Use phase of train bearings - train type 'Regina'. ESA-DBP

System Boundaries

Nature Boundary	The emissions to air and water are considered.
Time Boundary	Excerpt from the report, see 'Publication': ''The study is intended to illustrate the present situation, and the qualitative and quantitative information for the main processes are from the year 2001 until today. (NB: the report was written in 2003)
Geographical Boundary	Sweden
Other Boundaries	Excerpt from the report, see 'Publication': ''The environmental effects of industrial buildings, production of tools and machines, and the use of human labour are not included. The lifetime of bearings is generally given as basic rating life (L10h), which is 'the life that 90 percent of a sufficiently large group of apparently identical bearings can be expected to attain or exceed'. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2001
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The data for dismounting and refurbishment were taken from the sites where the process takes place. Data for detergent, oil and transport were take from existing databases.

Literature Reference	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2003--3.pdf
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity (accounted)	1.93E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity (non-accounted)	8.00E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Feedstock energy	3.10E+01			MJ	Technosphere	Sweden
	Output	Emission	Acid H+	2.33E-02			g	Water	Sweden
	Output	Emission	Al	8.96E-04			g	Water	Sweden
	Output	Emission	Aluminium sulphate	2.31E-02			g	Water	Sweden
	Output	Emission	AOX as Cl-	7.27E-05			g	Water	Sweden
	Output	Emission	Aromatic HC	8.58E-05			g	Air	Sweden
	Output	Emission	Aromatic HC	9.45E-04			g	Water	Sweden
	Output	Emission	Arsenic	1.12E-07			g	Air	Sweden
	Output	Emission	Arsenic	1.89E-06			g	Water	Sweden
	Output	Emission	Assay Al2O3	1.32E-02			g	Water	Sweden
	Output	Emission	Ba	3.87E-04			g	Water	Sweden
	Output	Emission	Be	1.40E-09			g	Air	Sweden
	Output	Emission	Benzene	6.01E-05			g	Air	Sweden
	Output	Emission	BOD	5.93E-03			g	Water	Sweden
	Output	Emission	Cd	1.88E-06			g	Air	Sweden
	Output	Emission	Cd	3.57E-05			g	Water	Sweden
	Output	Emission	CH4	4.19E-01			g	Air	Sweden
	Output	Emission	Chlorinated CH	1.48E-07			g	Water	Sweden
	Output	Emission	Cl-	7.27E+00			g	Water	Sweden
	Output	Emission	CN-	5.04E-07			g	Water	Sweden
	Output	Emission	CO	1.40E-08			g	Water	Sweden
	Output	Emission	Co	1.40E-08			g	Water	Sweden
	Output	Emission	CO	2.88E-01			g	Air	Sweden
	Output	Emission	CO2	3.41E+02			g	Air	Sweden
	Output	Emission	COD	6.10E-01			g	Water	Sweden
	Output	Emission	Cr	4.69E-05			g	Water	Sweden
	Output	Emission	Cr	9.82E-08			g	Air	Sweden
	Output	Emission	Cu	3.93E-07			g	Air	Sweden
	Output	Emission	Cu	4.66E-06			g	Water	Sweden
	Output	Emission	Dimethyl-aminoacrylate	1.97E-03			g	Water	Sweden
	Output	Emission	Dioxin	1.40E-13			g	Water	Sweden
	Output	Emission	Dioxine	2.01E-14			g	Air	Sweden
	Output	Emission	Dissolved solids	4.97E-04			g	Water	Sweden
	Output	Emission	DOC	3.65E-05			g	Water	Sweden
	Output	Emission	Dust	3.66E-01			g	Air	Sweden
	Output	Emission	F-	6.10E-01			g	Water	Sweden
	Output	Emission	Fat	7.71E-03			g	Water	Sweden
	Output	Emission	Fe	5.88E-02			g	Water	Sweden
	Output	Emission	H2SO4	3.22E-02			g	Water	Sweden
	Output	Emission	Halogenated HC	8.33E-10			g	Air	Sweden
	Output	Emission	Halon H1301	6.02E-07			g	Air	Sweden
	Output	Emission	HC	1.38E-02			g	Water	Sweden
	Output	Emission	HCl	2.04E-02			g	Water	Sweden
	Output	Emission	HCl	6.90E-03			g	Air	Sweden
	Output	Emission	HF	6.06E-05			g	Air	Sweden
	Output	Emission	Hg	1.04E-08			g	Water	Sweden
	Output	Emission	Hg	4.85E-07			g	Air	Sweden
	Output	Emission	HNO3	8.07E-03			g	Water	Sweden
	Output	Emission	Inorganic salts and acids	4.19E+00			g	Water	Sweden
	Output	Emission	Metals	1.11E-03			g	Air	Sweden
	Output	Emission	Metals	5.14E-03			g	Water	Sweden
	Output	Emission	Mn	5.07E-07			g	Air	Sweden

	Output	Emission	N2O	5.91E-03			g	Air	Sweden
	Output	Emission	NaOH	4.34E-02			g	Water	Sweden
	Output	Emission	NH3	6.06E-03			g	Air	Sweden
	Output	Emission	NH4+	2.97E-03			g	Water	Sweden
	Output	Emission	Ni	4.52E-05			g	Air	Sweden
	Output	Emission	Ni	5.14E-04			g	Water	Sweden
	Output	Emission	Nitrogen organic bound	1.83E-05			g	Water	Sweden
Notes: non methane HC	Output	Emission	NMVOC non-methane HC	2.24E+00			g	Air	Sweden
	Output	Emission	NO2	2.35E+00			g	Air	Sweden
	Output	Emission	NO3-	7.82E-04			g	Water	Sweden
	Output	Emission	NTA solution (100%)	3.88E-04			g	Water	Sweden
	Output	Emission	N-tot	8.37E-04			g	Water	Sweden
	Output	Emission	PAH policycl. Arom. HC	1.65E-06			g	Water	Sweden
	Output	Emission	PAH policycl. Arom. HC	6.46E-02			g	Air	Sweden
	Output	Emission	Pb	1.02E-05			g	Water	Sweden
	Output	Emission	Pb	7.14E-06			g	Air	Sweden
	Output	Emission	Phenol	7.47E-04			g	Water	Sweden
	Output	Emission	PO43-	6.05E-05			g	Water	Sweden
	Output	Emission	Potasium hydroxite (KOH)	4.56E-03			g	Water	Sweden
	Output	Emission	Radioactive	2.77E+00			g	Air	Sweden
	Output	Emission	Radioactive emissions	2.55E-02			g	Water	Sweden
	Output	Emission	S2-	6.88E-05			g	Water	Sweden
	Output	Emission	Silicates	8.15E-03			g	Water	Sweden
	Output	Emission	SO2	1.73E+00			g	Air	Sweden
	Output	Emission	SO4 2-	5.50E-02			g	Water	Sweden
	Output	Emission	Sodium gluconate	1.12E-03			g	Water	Sweden
	Output	Emission	Sodium hypochlorite	1.12E-03			g	Water	Sweden
	Output	Emission	Sodium ions	4.08E-02			g	Water	Sweden
	Output	Emission	Sodium kapryl-aminodipropionate	2.53E-03			g	Water	Sweden
	Output	Emission	Suspended solids	2.48E+01			g	Water	Sweden
	Output	Emission	TEX (aliphatic)	5.56E-03			g	Water	Sweden
	Output	Emission	TOC	3.48E-03			g	Water	Sweden
	Output	Emission	Toluene	1.53E-05			g	Water	Sweden
	Output	Emission	Tridecylalkoholetoxilat	2.53E-03			g	Water	Sweden
	Output	Emission	Zn	1.21E-05			g	Air	Sweden
	Output	Emission	Zn	9.15E-04			g	Water	Sweden
	Output	Residue	Solid waste	1.16E-01			kg	Technosphere	Sweden
	Output	Residue	Waste water	1.73E-03			m3	Technosphere	Sweden

About Inventory

Publication	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this LCA is to investigate the environmental impact of the use-phase for bearings in trains. Three generations of trains, so-called Electrical Multiple Units (EMUs), will be studied, and comparison will be made between processes within the life cycle of the bearings, and between the bearings in the different generations of EMUs.''
Detailed Purpose	Maintenance of the bearings has a great importance in a use phase so it was necessary to investigate its impact.
Commissioner	SKF Sverige AB - 415 50 Göteborg .
Practitioner	Karl Jonasson - .
Reviewer	Björn Andersson, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet)

	Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report, see 'Publication': ''SKF provides both bearings and bearing housings for trains, called axleboxes, which are mounted in direct connection with the train's wheels to make the wheel axle able to rotate (...). The bearings used for this purpose are in this study referred to as 'train bearings', even though there are other fields of application for bearings in trains (e.g. in the traction system). What type of rolling bearings used for the wheel axle varies according to performance needs and train design, but the function is essentially the same.''

SPINE LCI dataset: Maintenance of train bearings - train type 'X10'. ESA-DBP

Administrative	
Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Maintenance of train bearings - train type 'X10'. ESA-DBP
Functional Unit	2 axleboxes with bearings on a distance of 100 000km
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. The functional unit (fu) is here defined as 2 axleboxes with bearings, mounted on a wheel axle in use on its matched Electric Multiple Unit (EMU) during 100 000 km of transport. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year.''
Process Type	Gate to gate
Site	SKF Sverige AB 415 50 Göteborg
Sector	Land transport
Owner	SKF Sverige AB 415 50 Göteborg
Technical system description	The study was done for a a train 'X10' which was manufactured by ASEA/ABB Traction during the years 1982-1993. In this kind of train an un-sealed Spherical Roller Bearings (SRBs) were used. More than 100 of X10s were produced and most of them are still in use especially in Stokholm, Gotheburg and Skåne area. Excerpt from the study, see 'Publication': ''During the 1990s some of the X10s were rebuilt with a different interior, and renamed to X11. These are also included under the designation X10 in this study, as the basic performance is the same. (...) The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. (...) The SRB used in X1-A, X1-B and X10 has the SKF product number 23226 CC/C3W33, and the axleboxes are called 723724, 723721 and 4000850 respectively. The maintenance interval is of great importance for the analysis of the total environmental impact from the use of train bearings. However, the real maintenance interval is difficult to estimate, as the wheel axles can be sent to refurbishment for various reasons, e.g. misuse, derailment, warm-running, reached recommended maintenance interval etc. There is no statistics on how often the bearings are sent to refurbishment just because of malfunction of the bearings themselves. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year. For the bearings in X10 (...) the recommended maintenance interval (...) is 648 000 km. (...) These figures are based on evaluations of many factors, like climate, speed, lubrication and wheel

	axle and bearing construction, and do not reflect the performance of the bearings alone. (...) For the maintenance process, there is a number of sub-processes called dismounting of wheel axle, detergent production, naphtha production, lubricating oil and grease production, local processes, and waste oil handling.'' This process is included in the system described in: Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf Other processes in the CPM Database also included in the above publication: - Operation on train bearings - train type 'X1'. ESA-DBP - Operation on train bearings - train type 'X10'. ESA-DBP - Operation on train bearings - train type 'Regina'. ESA-DBP - Maintenance of train bearings - train type 'X1'. ESA-DBP - Maintenance of train bearings - train type 'Regina'. ESA-DBP - Use phase of train bearings - train type 'X1'. ESA-DBP - Use phase of train bearings - train type 'X10'. ESA-DBP - Use phase of train bearings - train type 'Regina'. ESA-DBP

System Boundaries

Nature Boundary	The emissions to air and water are considered.
Time Boundary	Excerpt from the report, see 'Publication': ''The study is intended to illustrate the present situation, and the qualitative and quantitative information for the main processes are from the year 2001 until today. (NB: the report was written in 2003)
Geographical Boundary	Sweden
Other Boundaries	Excerpt from the report, see 'Publication': ''The environmental effects of industrial buildings, production of tools and machines, and the use of human labour are not included. The lifetime of bearings is generally given as basic rating life (L10h), which is 'the life that 90 percent of a sufficiently large group of apparently identical bearings can be expected to attain or exceed'. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2001
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The data for dismounting and refurbishment were taken from the sites where the process takes place. Data for detergent, oil and transport were take from existing databases.
Literature Reference	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2003--3.pdf
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity (accounted)	1.93E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity (non-accounted)	8.75E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Feedstock energy	3.10E+01			MJ	Technosphere	Sweden
	Output	Emission	Acid H+	2.33E-02			g	Water	Sweden
	Output	Emission	Al	8.96E-04			g	Water	Sweden
	Output	Emission	Aluminium sulphate	2.31E-02			g	Water	Sweden
	Output	Emission	AOX as Cl-	7.27E-05			g	Water	Sweden
	Output	Emission	Aromatic HC	8.58E-05			g	Air	Sweden
	Output	Emission	Aromatic HC	9.45E-04			g	Water	Sweden

		Output	Emission	Arsenic	1.12E-07			g	Air	Sweden
		Output	Emission	Arsenic	1.89E-06			g	Water	Sweden
		Output	Emission	Assay Al2O3	1.32E-02			g	Water	Sweden
		Output	Emission	Ba	3.87E-04			g	Water	Sweden
		Output	Emission	Be	1.40E-09			g	Air	Sweden
		Output	Emission	Benzene	6.01E-05			g	Air	Sweden
		Output	Emission	BOD	5.93E-03			g	Water	Sweden
		Output	Emission	Cd	1.88E-06			g	Air	Sweden
		Output	Emission	Cd	3.57E-05			g	Water	Sweden
		Output	Emission	CH4	4.56E-01			g	Air	Sweden
		Output	Emission	Chlorinated CH	1.48E-07			g	Water	Sweden
		Output	Emission	Cl-	7.27E+00			g	Water	Sweden
		Output	Emission	CN-	5.04E-07			g	Water	Sweden
		Output	Emission	Co	1.40E-08			g	Water	Sweden
		Output	Emission	CO	3.01E-01			g	Air	Sweden
		Output	Emission	CO2	3.47E+02			g	Air	Sweden
		Output	Emission	COD	6.10E-01			g	Water	Sweden
		Output	Emission	Cr	4.69E-05			g	Water	Sweden
		Output	Emission	Cr	9.82E-08			g	Air	Sweden
		Output	Emission	Cu	3.93E-07			g	Air	Sweden
		Output	Emission	Cu	4.66E-06			g	Water	Sweden
		Output	Emission	Dimethyl-aminoacrylate	1.97E-03			g	Water	Sweden
		Output	Emission	Dioxin	1.40E-13			g	Water	Sweden
		Output	Emission	Dioxin	2.01E-14			g	Air	Sweden
		Output	Emission	Dissolved solids	4.97E-04			g	Water	Sweden
		Output	Emission	DOC	3.65E-05			g	Water	Sweden
		Output	Emission	Dust	3.66E-01			g	Air	Sweden
		Output	Emission	F-	6.10E-01			g	Water	Sweden
		Output	Emission	Fat	7.71E-03			g	Water	Sweden
		Output	Emission	Fe	5.88E-02			g	Water	Sweden
		Output	Emission	H2SO4	3.22E-02			g	Water	Sweden
		Output	Emission	Halogenated HC	8.33E-10			g	Air	Sweden
		Output	Emission	Halon H1301	6.02E-07			g	Air	Sweden
		Output	Emission	HC	1.38E-02			g	Water	Sweden
		Output	Emission	HCl	2.04E-02			g	Water	Sweden
		Output	Emission	HCl	6.90E-03			g	Air	Sweden
		Output	Emission	HF	6.06E-05			g	Air	Sweden
		Output	Emission	Hg	1.04E-08			g	Water	Sweden
		Output	Emission	Hg	4.85E-07			g	Air	Sweden
		Output	Emission	HNO3	8.07E-03			g	Water	Sweden
		Output	Emission	Inorganic salts and acids	4.19E+00			g	Water	Sweden
		Output	Emission	Metals	1.11E-03			g	Air	Sweden
		Output	Emission	Metals	5.14E-03			g	Water	Sweden
		Output	Emission	Mn	5.07E-07			g	Air	Sweden
		Output	Emission	N2O	6.44-03			g	Air	Sweden
		Output	Emission	NaOH	4.34E-02			g	Water	Sweden
		Output	Emission	NH3	6.23E-03			g	Air	Sweden
		Output	Emission	NH4+	2.97E-03			g	Water	Sweden
		Output	Emission	Ni	4.52E-05			g	Air	Sweden
		Output	Emission	Ni	5.14E-04			g	Water	Sweden
		Output	Emission	Nitrogen organic bound	1.83E-05			g	Water	Sweden
	Notes: non methane HC	Output	Emission	NMVOC non-methane HC	2.24E+00			g	Air	Sweden
		Output	Emission	NO2	2.35E+00			g	Air	Sweden
		Output	Emission	NO3-	7.82E-04			g	Water	Sweden
		Output	Emission	NTA solution (100%)	3.88E-04			g	Water	Sweden
		Output	Emission	N-tot	8.37E-04			g	Water	Sweden
		Output	Emission	PAH policycl. Arom. HC	1.65E-06			g	Water	Sweden
		Output	Emission	PAH policycl. Arom. HC	6.46E-02			g	Air	Sweden
		Output	Emission	Pb	1.02E-05			g	Water	Sweden
		Output	Emission	Pb	7.14E-06			g	Air	Sweden
		Output	Emission	Phenol	7.47E-04			g	Water	Sweden
		Output	Emission	PO43-	6.05E-05			g	Water	Sweden
		Output	Emission	Potasium hydroxite (KOH)	4.56E-03			g	Water	Sweden
		Output	Emission	Radioactive	2.77E+00			g	Air	Sweden

	Output	Emission	Radioactive emissions	2.55E-02			g	Water	Sweden
	Output	Emission	S2-	6.88E-05			g	Water	Sweden
	Output	Emission	Silicates	8.15E-03			g	Water	Sweden
	Output	Emission	SO2	1.74E+00			g	Air	Sweden
	Output	Emission	SO4 2-	5.50E-02			g	Water	Sweden
	Output	Emission	Sodium gluconate	1.12E-03			g	Water	Sweden
	Output	Emission	Sodium hypochlorite	1.12E-03			g	Water	Sweden
	Output	Emission	Sodium ions	4.08E-02			g	Water	Sweden
	Output	Emission	Sodium kapryl-aminodipropionate	2.53E-03			g	Water	Sweden
	Output	Emission	Suspended solids	2.48E+01			g	Water	Sweden
	Output	Emission	TEX (aliphatic)	5.56E-03			g	Water	Sweden
	Output	Emission	TOC	3.48E-03			g	Water	Sweden
	Output	Emission	Toluene	1.53E-05			g	Water	Sweden
	Output	Emission	Tridecylalkoholetoxilat	2.53E-03			g	Water	Sweden
	Output	Emission	Zn	1.21E-05			g	Air	Sweden
	Output	Emission	Zn	9.15E-04			g	Water	Sweden
	Output	Residue	Solid waste	1.26E-01			kg	Technosphere	Sweden
	Output	Residue	Waste water	1.73E-03			m3	Technosphere	Sweden

About Inventory

Publication	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this LCA is to investigate the environmental impact of the use-phase for bearings in trains. Three generations of trains, so-called Electrical Multiple Units (EMUs), will be studied, and comparison will be made between processes within the life cycle of the bearings, and between the bearings in the different generations of EMUs.''
Detailed Purpose	Maintenance of the bearings has a great importance in a use phase so it was necessary to investigate its impact.
Commissioner	SKF Sverige AB - 415 50 Göteborg .
Practitioner	Karl Jonasson - .
Reviewer	Björn Andersson, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report, see 'Publication': ''SKF provides both bearings and bearing housings for trains, called axleboxes, which are mounted in direct connection with the train's wheels to make the wheel axle able to rotate (...). The bearings used for this purpose are in this study referred to as 'train bearings', even though there are other fields of application for bearings in trains (e.g. in the traction system). What type of rolling bearings used for the wheel axle varies according to performance needs and train design, but the function is essentially the same.''

SPINE LCI dataset: Manufacturing of brass cages at SKFs site in Göteborg

Administrative

Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Manufacturing of brass cages at SKFs site in Göteborg
Functional Unit	One brass cage, 55,6 kg
Functional Unit Explanation	One SKF spherical roller bearing 232/530 consists of following components: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 rollers (coated or non-coated) The functional unit for this process is one brass cage. Note that this is only a subactivity for ''Production of brass cages used for spherical roller bearings''. The total data in the activity ''Production of brass cages used for spherical roller bearings'' can finally be used (together with data for the other ingoing components) to calculate environmental impact for a complete SKF spherical roller bearing 232/530. Dimensions of the bearing: di= 530 mm dy= 980 mm breadth= 355 mm
Process Type	Gate to gate
Site	SKF Sverige AB415 50 GÖTEBORG
Sector	Materials and components
Owner	SKF Sverige AB415 50 GÖTEBORG
Technical system description	This activity describes a process step included in the system ''Production of brass cages used for spherical roller bearings'', also available in the SPINE@CPM database. Turned brass cylinders are bought from BecoTek AS in Norway (see ''Production of turned brass cylinders''). At the SKF plant in Göteborg the brass cylinders are treated and processed in several steps to obtain the desired shape. 1. First the cylinders are turned in the Morando lathe (66 minutes). 2. The cylinders are then drilled. The drilling takes about 93 minutes and is the most time consuming step in the process. 3. To get rid of sharp edges from the drilling, the cages are then ground by hand. 4. The last step is to trumble the cages with trumble chips made of ceramic stones to get a smooth surface. The cages are then transported, by industrial trucks, to the C-factory at SKF where the final assembly takes place. (1 km electric truck transport is included) The trumbling chips are not included in this study, since the amount of chips needed for one cage was insignificant. Also the energy consumption for the trumbling of the cages was neglected since it is very small in comparison to the energy consumption of the other process equipment. The brass-scrap from the SKF process is transported to Västerås, Sweden, for complete recycling. This transport and recycling activity is NOT included in this dataset. The cutting fluid is transported to Halmstad for destruction and use as energy source in the Cement-industry. This transport and destruction activity is NOT included in this dataset. See the activity ''Production of brass cages used for spherical roller bearings'' for futher information.

System Boundaries	
Nature Boundary	No emissions to air are included since they were not known and measured. The trumble chips are not followed from the cradle and not to the grave. The brass scrap that leaves the system is considered to be a co-product since it is used as raw material for new products and thus the boundary is the technosphere. The mineral oil in the cutting fluid has NOT been accounted for. The cutting fluid is an emulsion with water and 4% of CASTROL SW 3420. According to the product data sheet for CASTROL SW 3420 it consists of 40% mineral oil. Databases for ''Extraction of crude oil'' and ''Refining of crude oil'' from SPINE@CPM can be used for tracing the mineral oil to its

	cradle. The activity ''Combustion of waste oil'' can be used for following the mineral oil to its grave. This is also a separate activity that can be found in SPINE@CPM database.
Time Boundary	The data is collected during autumn 2002. No changes in the procedure are planned for the nearest future.
Geographical Boundary	The manufacturing of cages takes place at SKF in Göteborg, Sweden.
Other Boundaries	In the activity ''Manufacturing of brass cages at SKFs site in Göteborg'' also internal transport within SKF industrial area 1 km electric truck is included and the electricity production needed for this (0,75 kWh/km) This assumption of energy consumption is made at BeTe Trucks AB in Sweden. The electricity production is NOT included. Swedish average electricity production should be used.
Allocations	For the process at SKF in Göteborg the data is production specific to the specific cage. For other cages with different dimensions the processing time in the different process equipment can vary, and thus also the energy consumption can vary.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'
Method	Most of the data is obtained from estimations from the production manager Christer Landgren. The finished brass cage is weighted to obtain the correct weight, 55,6 kg. Other data is descibed for each flow.
Literature Reference	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2003--3.pdf
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 02-08-01 - 02-12-31 Data type: Calculated Method: There is a tank with a volume of 11000 litres. This tank is changed 2 times every year. According to the plant manager, 70 cages are manufactured each day ==> 25550 cages/year. This means 0,86 litres / cage. The liquid consists of 4 % Castrol SW3420. This product consists of 40% mineral oil according to the product data sheet. The amount of mineral oil should be accounted for. (extraction and refining of crude oil) The amount of emulsion (880 l/year) must be followed to the grave.	Input	Refined resource	Cutting fluid	0.86			kg	Technosphere	Sweden
Date concieved: 02-08-01 - 02-12-31 Data type: Derived, mixed Method: For each process equipment the effect demand was meassured. This effect number was multiplied with the time needed for one cage to be processed. The morando lathe = 66 min/ cage, 10,9 kW The XCB 1200-3 drilling machine = 93 min/cage, 12 kW The internal transport by electric truck is also included: 1 km. Electric truck: 0,75 kWh/km (assumptions made by BeTe Truck AB in Sweden) ==> (66/60)*10,9 + (93/60)*12 + 0,75 = 31,35 kWh/cage	Input	Refined resource	Electricity	31.35			kWh	Technosphere	Sweden
	Input	Refined resource	Turned brass cylinders	205			kg	Technosphere	Norway
	Output	Co-product	Scrap	149.4			kg	Technosphere	Sweden
	Output	Product	Brass cage	55.6			kg	Technosphere	Sweden

	Output	Residue	Cutting fluid	0.86			kg	Technosphere	Sweden

About Inventory	
Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for production of brass cages of this dimension at the specific site at SKF in Göteborg, Sweden.
About Data	Data is gathered from meassurements in the cage factory and from interviews with Christer Landgren, SKF Sverige AB.
Notes	

SPINE LCI dataset: Manufacturing of CD-R (Compact Disc-Recordable). ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Manufacturing of CD-R (Compact Disc-Recordable). ESA-DBP
Functional Unit	1 pce of CD-R
Functional Unit Explanation	1 compact disc-recordable.
Process Type	Gate to gate
Site	LOGOS, Göteborg, Sweden
Sector	Manufacturing
Owner	LOGOS, Göteborg, Sweden
Technical system description	Excerpt from the report, see 'Publication': ''CD-R has got a recording layer of cyanide dye between the PC and the reflecting layer and the reflecting layer is made of gold (...). The cyanide dye is sensitive to ultraviolet light. The recording is done by ultraviolet laser which changes the layer to become absorbing instead of transparent. (...) - The manufacturing chain starts with preparing a glass disc with a photo resistant layer. The glass disc is then recorded with a laser. In the CD-R manufacturing only tracks for the laser beam are recorded. The following step is to develop and coat the surface with thin layer of metal.

	- The next step is electroforming, where the developed disc is covered by nickel. The nickel part which is called the metal father and the glass disc are then separated. Once again electroforming is used to produce a negative nickel copy which is called the mother. The metal mother is made as a safety copy from which it is easy to make a second metal father which can be used as a stamper. - The stamper is put in a moulding machine where it is brought in contact with melted polycarbonate under high pressure, it conforms to the stampers contours, producing a substrate disc with pits or tracks. For the CD-R manufacturing an additional step of spin coating the surface of the disc with a very thin recording dye layer is carried out before the next step. - To the moulded disc the reflective layer is applied by magnetron suttering, this layer usually consists of (...) gold. - To protect the thin and sensitive metal layer the disc is spin coated with an acrylic resin. Finally it is common to give the discs a label by screen printing with acrylic resin. The recording area of a CD, between the 46 mm inner and 117 mm outer radius, is 90.85cm2. This area have been used to calculate to amounts of material used in some of the stages. (...) The finished product is blank CD with no stored data, therefore a recording session will follow. (...) When the CD is finished it is put in Jewel box together with a booklet. The weight of a CD library will be less than 200g including transport packaging.'' (NB: excluded from the study) This process is included in the system described in: Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Manufacturing of CD-ROM (Compact Disc - Read Only Memory). ESA-DBP - Dioctyl phthalate (DOP) production. ESA-DBP - Cultivation and felling of trees for papermaking. ESA-DBP - Cardboard production (MDF based). ESA-DBP - Production of copypaper. ESA-DBP - Production of orthoxylene. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials). Polycarbonate will be reused.
Time Boundary	1996-1997
Geographical Boundary	Sweden
Other Boundaries	The recording session requires a small amount of electricity but no data for this have been available and is therefore omitted in this study. (...) The transport packaging is not inluded in this study. The mastering of the father, stamper will not be included since the same stamper can be used to all discs why it can be considered as a part of the machine and the production of machines are not included in this study. From the manufacturing of one CD, 1.80g polycarbonate is wasted and sent to recycling. Of this recycled PC 40%, (weight), is coated with metal.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1996,1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''(...) the manufacture is very similar to the one of regular CDs. Therefore have data from CD-ROM production been used with replacement of some of the raw materials.''
Literature Reference	Tsujino, K. Sony, Recording Media Laboratory Europe. Köln, Germany, November 1996 Hedegård, Erik. Market manager in LOGOS, Göteborg, Sweden, January 1997
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***

	Input	Refined resource	Acrylic resin	1.00E-01			g	Technosphere	Sweden
	Input	Refined resource	Cyanide dye	1.00E+00			mg	Technosphere	Sweden
	Input	Refined resource	Electricity	8.00E-02			kWh	Technosphere	Sweden
	Input	Refined resource	Gold	2.00E+01			mg	Technosphere	Sweden
	Input	Refined resource	Polycarbonate	1.49E+01			g	Technosphere	Sweden
	Output	Product	CD-R (recordable disc)	1.00E+00			pce	Technosphere	Sweden
Notes: will be reused	Output	Residue	Polycarbonate	9.00E-01			g	Technosphere	Sweden

About Inventory	
Publication	Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	The study was done for the purpose of master thesis.
Detailed Purpose	Excerpt from the report: ''The goal of this study is to undertake an life cycle assessment (LCA) of different alternatives for Ericsson to provide their customers with reference libraries to the Ericsson Consolo MD110 telephone exchange system. The different documentation alternatives investigated in this study are: plastic ring binders, paperbacks, CD-R records and CD-ROM records.''
Commissioner	Ericsson, Stockholm, Sweden - .
Practitioner	Torsten Beckman - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The inventory results for the whole life cycle (from cradle to grave) of binders, paperbacks, CD-Rs and CD-ROMs can be found in the reference report.

SPINE LCI dataset: Manufacturing of CD-ROM (Compact Disc - Read Only Memory). ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Manufacturing of CD-ROM (Compact Disc - Read Only Memory). ESA-DBP
Functional Unit	1 pce of CD-ROM
Functional Unit Explanation	1 Compact Disc - Read Only Memory
Process Type	Gate to gate
Site	LOGOS, Göteborg, Sweden

Sector	Manufacturing
Owner	LOGOS, Göteborg, Sweden
Technical system description	Excerpt from the report, see 'Publication': (...) - The manufacturing chain starts with preparing a glass disc with a photo resistant layer. The glass disc is then recorded with a laser. In the CD-R manufacturing only tracks for the laser beam are recorded. The following step is to develop and coat the surface with thin layer of metal. - The next step is electroforming, where the developed disc is covered by nickel. The nickel part which is called the metal father and the glass disc are then separated. Once again electroforming is used to produce a negative nickel copy which is called the mother. The metal mother is made as a safety copy from which it is easy to make a second metal father which can be used as a stamper. - The stamper is put in a moulding machine where it is brought in contact with melted polycarbonate under high pressure, it conforms to the stampers contours, producing a substrate disc with pits or tracks. (...) - To the moulded disc the reflective layer is applied by magnetron suttering, this layer usually consists of aluminium (...). - To protect the thin and sensitive metal layer the disc is spin coated with an acrylic resin. Finally it is common to give the discs a label by screen printing with acrylic resin. The recording area of a CD, between the 46 mm inner and 117 mm outer radius, is 90.85cm2. This area have been used to calculate to amounts of material used in some of the stages. (...) When the CD is finished it is put in Jewel box together with a booklet. The weight of a CD library will be less than 200g including transport packaging.'' (NB: excluded from the study) This process is included in the system described in: Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Manufacturing of CD-R (Compact Disc-Recordable). ESA-DBP - Dioctyl phthalate (DOP) production. ESA-DBP - Cultivation and felling of trees for papermaking. ESA-DBP - Cardboard production (MDF based). ESA-DBP - Production of copypaper. ESA-DBP - Production of orthoxylene. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials). Polycarbonate will be reused.
Time Boundary	1996-1997
Geographical Boundary	Sweden
Other Boundaries	The recording session requires a small amount of electricity but no data for this have been available and is therefore omitted in this study. (...) The transport packaging is not inluded in this study. The mastering of the father, stamper will not be included since the same stamper can be used to all discs why it can be considered as a part of the machine and the production of machines are not included in this study. From the manufacturing of one CD, 1.80g polycarbonate is wasted and sent to recycling. Of this recycled PC 40%, (weight), is coated with metal.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1996,1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Gathered through the personal contact and adapted from other report.
Literature Reference	Tsujino, K. Sony, Recording Media Laboratory Europe. Köln, Germany, November 1996 Hedegård, Erik. Market manager in LOGOS, Göteborg, Sweden, January 1997
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Acrylic resin	1.00E-01			g	Technosphere	Sweden
	Input	Refined resource	Aluminium	4.00E-03			g	Technosphere	Sweden
	Input	Refined resource	Electricity	8.00E-02			g	Technosphere	Sweden
	Input	Refined resource	Polycarbonate	1.49E+01			g	Technosphere	Sweden
	Output	Product	CD-ROM (read only memory disc)	1.00E+00			pce	Technosphere	Sweden
	Output	Residue	Polycarbonate	9.00E-01			g	Technosphere	Sweden

About Inventory

Publication	Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	The study was done for the purpose of master thesis.
Detailed Purpose	Excerpt from the report: ''The goal of this study is to undertake an life cycle assessment (LCA) of different alternatives for Ericsson to provide their customers with reference libraries to the Ericsson Consolo MD110 telephone exchange system. The different documentation alternatives investigated in this study are: plastic ring binders, paperbacks, CD-R records and CD-ROM records.''
Commissioner	Ericsson, Stockholm, Sweden - .
Practitioner	Torsten Beckman - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The inventory results for the whole life cycle (from cradle to grave) of binders, paperbacks, CD-Rs and CD-ROMs can be found in the reference report.

SPINE LCI dataset: Manufacturing of Cold Rolled Steel Tubes, 41,55 x 37,21 or 47,75 x 41,01 mm

Administrative

Finished	Y
Date Completed	2002-08
Copyright	
Availability	Public

Technical System

Name	Manufacturing of Cold Rolled Steel Tubes, 41,55 x 37,21 or 47,75 x 41,01 mm
Functional Unit	1 ton Cold rolled steel tubes, 41,55 x 37,21 or 47,75 x 41,01 mm
Functional Unit Explanation	41,55 x 37,21 means that the outer diameter is 41,55 mm and the inner diameter 37,21 mm. It is the same for 47,75 x 41,01 mm. The steel quality is SKF3 100Cr6.

Process Type	Gate to gate
Site	Cold Rolling Mill Ovako Steel AB 813 82 Hofors Sweden
Sector	Materials and components
Owner	Cold Rolling Mill Ovako Steel AB 813 82 Hofors Sweden
Technical system description	The Colled rolled steel tubes of diameters 41,55 x 37,21 mm and 47,75 x 41,01 mm are manufactured from Hot rolled steel tubes of diameter 70,7 x 47,5 mm. The steel quality is SKF3 100Cr6. The tubes are purchased from the Hot rolling mill at the same manufacturing plant, Ovako Steel AB. The production of Hot rolled steel tubes is not included here, but are presented as a separate data set (see the activity about ''Manufacturing of Hot Rolled Steel Tubes''). Manufacturing processes included in this activity are: 1. Cold rolling 2. Surface treatment: a. Grinding b. Peeling 3. Inspection (ultra sonic) The tubes are processed by cold rolling and then passed on for surface treatment. Depending on customer demand, the surface treatment is either grinding or peeling. The difference between grinding and peeling is mostly cosmetic. The grinding and peeling both result in about the same amount of steel scrap and the scrap is recycled in both cases. After surface treatment the tubes are controlled for cracks with ultra sound (inspection), cut and delivered. Cleaning of process water is not included in the system.

System Boundaries

Nature Boundary	Emissions to air are not included due to lack of data. Emissions to water are considered and the recipient is Hoån, Sweden.
Time Boundary	The data is based on the production in 1998.
Geographical Boundary	The cold rolling mill is located in Hofors, Sweden.
Other Boundaries	Production of refined resources is not included. Refined resources not included: - Hot rolled steel tube - District heating - Emulsion - Hydraulic oil - Steam Production of electricity is not included. Waste treatment is not included. Subsystems concearning employees are not included. Transports are not included. Maintenance of machinery is not included.
Allocations	Allocations have been made according to weight. At the Ovako Steel Cold Rolling Mill, steel tubes can be produced by either cold rolling or cold drawing. Data that corresponds to cold drawing is excluded because the tubes in this activity are produced by cold rolling. The total amount of emissions and waste for production of all cold rolled steel tubes are divided by the total amount of produced tonnes of steel tubes. This gives the amount of emissions and waste that corresponds to the production of 1 ton cold rolled steel tubes.
Systems Expansions	Not relevant

Flow Data

General Activity QMetaData

Date Conceived	1998-01-01 - 2000-02-28
Data Type	Derived, unspecified
Represents	Ovako Steel AB in Hofors
Method	The data is based on production data at the Cold Rolling Mill at Ovako Steel AB in Hofors, Sweden.
Literature Reference	Ovako Steel internal information as presented by Rickard Qvarfort at the cold rolling mill and from environmental report, Ovako 1998.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how.	Input	Natural resource	Water	1.2			l	Technosphere	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how.	Input	Refined resource	District heating	125			kWh	Technosphere	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how.	Input	Refined resource	Electricity	223			kWh	Technosphere	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how.	Input	Refined resource	Emulsion	0.8			l	Technosphere	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how.	Input	Refined resource	Hot rolled steel tube	1.111			tonne	Technosphere	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how.	Input	Refined resource	Hydraulic oil	0.8			l	Technosphere	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how.	Input	Refined resource	Steam	249			kWh	Technosphere	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how. The process water is cleaned before released into Hoån. After cleaning, 0,00243 mg H2SO4 is released into the river for 1 ton of produced Cold rolled steel tubes. (This cleaning is not included in the system.)	Output	Emission	H2SO4	0.00243			mg	River	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how.	Output	Product	Cold rolled steel tube	1			tonne	Technosphere	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how. The emulsions are sent to a waste treatment company for destruction.	Output	Residue	Emulsion	37.2			kg	Technosphere	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how. The mixed oils are sent to a waste treatment company for destruction.	Output	Residue	Mixed oils	0.87			kg	Technosphere	Sweden
Data type: Derived, unspecified Notes: Derived by Rickard Qvarfort at the cold rolling mill, not known how. The steel scrap is recycled back to the scrap yard at Ovako Steel.	Output	Residue	Steel scrap	111			kg	Technosphere	Sweden

About Inventory

Publication	The data will be published in the Master thesis: ''LCA for the Plain Bearing GE30, Manufactured from Steel Tubes'' by Jesper Nilsson, Göteborgs Universitet/Chalmers University of Technology in 2001. -- Data documented by Jesper Nilsson, MSc thesis worker at SKF. Documentation reviewed by Karolina Flemström, IMI, Chalmers University of Technology Data published in SPINE@CPM 2002-09-09
Intended User	Suppliers and buyers of steel
General Purpose	The general purpose for this data inventory is to document data in a way suitable for LCA studies.
Detailed Purpose	The data will be used in the Master thesis: ''LCA for the Plain Bearing GE30, Manufactured from Steel Tubes'' by Jesper Nilsson, Göteborgs Universitet/Chalmers University of Technology in 2001. The reason for carrying out this LCA was to describe the environmental performances of the SKF plain bearing GE30. The main purpose was to find out which activities during the life cycle of the GE30, that contribute to most negative environmental impacts. GE30 was chosen because there already was some life cycle inventory data available for this bearing type and because it is the most sold bearing at SKF Gleitlager. The plain bearing GE30 is manufactured from cold rolled steel tubes of quality SKF3, 100Cr6. One of the activities included is production of Cold rolled steel tubes.
Commissioner	SKF Nova - Chalmers Teknikpark 412 88 Göteborg Sweden .

Practitioner	Jesper Nilsson - Nybohovsbacken 31, 4 tr 121 63 Stockholm Sweden .
Reviewer	
Applicability	The data is applicable to the production of Cold rolled steel tubes of steel quality SKF3, 100Cr6 at the Cold Rolling Mill at Ovako Steel in Hofors, Sweden. The data is an average of all tubes manufactured by cold rolling at Ovako Steel. The cold rolled steel tubes have gone through several manufacturing steps at the Ovako Steel factory in Hofors. These steps are all presented as separate data sets, see the activities about: 1. ''Production of bearing steel'' 2. ''Manufacturing of Hot Rolled Round Steel Billets'' 3. ''Manufacturing of Hot Rolled Steel Tubes''
About Data	The data is provided by Rickard Qvarfort at the Cold rolling mill at Ovako Steel AB in Hofors, Sweden. It is not specified if the data is derived, monitored, estimated, from economical information or calculated in some other way. All data was recieved as annual inputs and outputs for the entire Cold rolling mill.
Notes	

SPINE LCI dataset: Manufacturing of Hot Rolled Round Steel Billets, 80 mm

Administrative	
Finished	Y
Date Completed	2002-08
Copyright	
Availability	Public

Technical System	
Name	Manufacturing of Hot Rolled Round Steel Billets, 80 mm
Functional Unit	1 ton of Hot rolled round steel billets, 80 mm
Functional Unit Explanation	The steel quality of the round billets of diameter 80 mm is SKF3, 100Cr6.
Process Type	Gate to gate
Site	Rolling Mill Ovako Steel AB 813 82 Hofors Sweden
Sector	Materials and components
Owner	Rolling Mill Ovako Steel AB 813 82 Hofors Sweden
Technical system description	The Hot rolled round steel billets are manufactured from Steel ingots, which are purchased from the Steel mill at Ovako Steel. The production of Steel ingots is not included here, but is presented as a separate data set (see the activity about ''Production of bearing steel''). The steel quality is SKF3, 100Cr6. These process steps are included in the data set: 1. Pit Furnace 2. Billet rolling, stand 1 3. Oxygen scarfing 4. Billet rolling, stand 2 5. Billet rolling, stand 3 6. Partitioning (cutting) 7. Cooling bed 8. Shot blasting 9. Surface treatment if needed after inspection (grinding) When the ingots are put in the pit furnace they have a temperature of about 800 degrees Celsius. Six of the furnaces have oxyfuel technology, six have oil/air combustion and one is heated with liquefied petroleum gas. In the furnace the ingots are heated up to rolling temperature which is about 1200 degrees. When the rolling temperature is reached the ingots are soaked for three hours. The ingots are rolled in 26 passes down to 220 square and are thereafter sent through the

	oxygen scarfing. Added in the oxygen scarfing process are LPG, oxygen, polymers and water. In rolling stand 2 the ingots are rolled down to 150 mm square billets and passed on to rolling stand 3. In rolling stand 3 the rolling of round billets of different diameters take place (80, 90 and 120 mm). These are the final dimensions and the billets are now cut (partitioning) and put on a cooling bed until the temperature is at a maximum of 100 degrees. After that the billets are sand blasted, inspected and surface defects, if any, are removed by grinding. The process steps 1- 4 are called Production line I and process steps 5- 9 are called Production line II.

System Boundaries

Nature Boundary	Emissions to air are included. Emissions to water are not included due to lack of data. The recipient of waste water is Hoån. Residues to the technosphere are not further followed to the grave. Landfilled residues are deposited within Ovako Steel land property, but possible leakage to soil and ground water is not known.
Time Boundary	The data is based on the production of steel billets in 1998.
Geographical Boundary	The Ovako Steel Rolling Mill is located in Hofors, Sweden.
Other Boundaries	Production of refined resources is not included. Refined resources not included: - Steel ingot - Brick - Dolomite - Grease - Hydraulic oil - Light fuel oil - LPG - N2 - O2 - Polymers Production of electricity is not included. Transports are not included, exept for internal transport with electrical industrial truck. Waste treatment is not included. Subsystems concearing employees are not included. Recycling of steel scrap is not included.
Allocations	Allocations have been made according to weight. Specification of weights of the flows for production of billets at the : - Total weight of steel ingots into Production line I; 410 427 tons - Total weight of billets out from Production line II; 156 575 tons - Total weight of billets for tubes out from Production line II; 106 761 tons - Total weight of billets out from Production line III; 183 225 tons For description of Production line I(process step 1-4) and II (process step 4-9) see Function. Production line III is the production of square billets and data for this flow is not included in this data set, except that the weight into Production line III has been taken in consideration in the allocations. Allocations: - The different steel billets produced at Ovako Steel are 80, 90, 120 mm round and 150 mm square. - The manufacturing process is the same until after rolling stand 2, where all billets are 150 mm square. - After that the billets go to partitioning (Production line III) or to further rolling procedures (Production line II). - The total output weight forProduction line II and III is 339 000 tons. Therefor Production line II counts for 46,1% of Production line I. - For the input and output data in Production line II no difference has been made between the different dimensions of round billets. In other words it is assumed that the billets are processed equally regarding time, oil, etc. - Only the weight of the billets has been used as basis for allocation. - The total weight of round billets produced in Production line IIwhere 156 575 tons. Therefor these tubes count for all of the input and output data specific for flow 2. - As an example these billets counts for 46,1 % of electricity consumption in Production line I and all of the electricity consumptin in Production line II.
Systems Expansions	Not relevant

Flow Data

General Activity QMetaData

Date Conceived	1998-01-01 - 2000-02-28
Data Type	Derived, mixed
Represents	Ovako Steel AB in Hofors
Method	The data is based on productin data at the Rolling Mill at Ovako Steel AB in Hofors, Sweden. Emission data is all monitored by authorised companies, except for CO2 emissions that are derived from the carbon content in the combusted fuel.
Literature Reference	Internal information from Ovako Steel as recived from Lars-Gunnar Larsson at the rolling mill at Ovako Steel AB.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Data type: Monitored data, continuous Notes: Measured by B. Kvarnström, not specified how.	Input	Natural resource	Municipal water	0.14			m3	Ground	Sweden
Data type: Unspecified, guesstimate Notes: The use of Surface water is estimated by Lars-Gunnar Larsson at the Rolling Mill at Ovako Steel AB in Hofors.	Input	Natural resource	Surface water	2.01			m3	River	Sweden
Data type: Economical information Notes: Purchased weight.	Input	Refined resource	Brick	0.16			kg	Technosphere	Sweden
Data type: Economical information Notes: Purchased weight	Input	Refined resource	Dolomite	0.029			kg	Technosphere	Sweden
Data type: Monitored data, continuous Notes: Not specified by provider from Ovako Steel, Lars-Gunnar Larsson.	Input	Refined resource	Electricity	105			kWh	Technosphere	Sweden
Data type: Economical information Notes: Purchased weight	Input	Refined resource	Grease	0.054			kg	Technosphere	Sweden
Data type: Monitored data, discrete Notes: Measured by Per Hellberg, not specified how.	Input	Refined resource	Hydraulic oil	0.115			l	Technosphere	Sweden
Data type: Monitored data, discrete Method: The consumption of Light fuel oil is measured to 17,96 kg for production of 1 ton Hot rolled round steel billets. The energy content of light fuel oil is 11,6 kWh/kg according to Physics Handbook. The energy content of 17,96 kg light fuel oil therefore is 208 kWh. Literature: Physics handbook, T-8.5, 1996 Notes: Measured by T. Klaussen, not specified how.	Input	Refined resource	Light fuel oil	208			kWh	Technosphere	Sweden
Data type: Monitored data, discrete Method: The consumption of LPG is measured to 3,442 kg for production of 1 ton Hot rolled round steel billets. The energy content of LPG is 12,8 kWh/kg according to Physics Handbook. The energy content of 3,442 kg LPG therefore is 44,1 kWh. Literature: Physics handbook, T-8.5, 1996 Notes: Measured by T. Klaussen, not known how. LPG is Liquefied Petroleum Gas. The gas is a mixture of Propane (C3H8) and Butane (C4H10).	Input	Refined resource	LPG	44.1			kWh	Technosphere	Sweden
Data type: Unspecified Notes: Provider of information T. Klaussen.	Input	Refined resource	N2	0.006			m3	Technosphere	Sweden
Data type: Monitored data, discrete Notes: Measured by T. Klaussen, not known how. The Oxygen gas has a temperature of 15 degrees Celsius.	Input	Refined resource	O2	27.7			m3	Technosphere	Sweden
Data type: Unspecified Notes: The data origin is not known, but provider of information is Stewen Persson at Ovako Steel. Chemical name: 2-propenic acid with 2-polyacrylamide	Input	Refined resource	Polymers	5.15			ml	Technosphere	Sweden
Data type: Economical information Notes: Purchased from the Steel Mill. The temperature is about 800 degrees Celsius.	Input	Refined resource	Steel ingot	1.202			tonne	Technosphere	Sweden

Data type: Derived, unspecified Notes: Data is calculated by H. Burtsoff at Ovako Steel, not known how.	Output	Emission	CO2	43.1			kg	Rural air	Sweden
Data type: Monitored data, discrete Notes: Measured by H. Burtsoff, not known how.	Output	Emission	Dust	25.3			mg	Rural air	Sweden
Data type: Estimated from similarity Notes: Estimated from similarity by H. Burtsoff, not known how.	Output	Emission	NOx	177			g	Rural air	Sweden
Data type: Derived, unspecified Notes: Data is calculated by H. Burtsoff at Ovako Steel, not known how.	Output	Emission	SO2	53			g	Rural air	Sweden
Data type: Unspecified, guesstimate Notes: The output of water is estimated to be the same as the sum of municipal water input and surface water input. The surface water input is estimated by Lars-Gunnar Larsson at the Rolling Mill at Ovako Steel AB in Hofors.	Output	Emission	Waste water	2.15			m3	River	Sweden
	Output	Product	Hot rolled round steel billets	1			tonne	Technosphere	Sweden
Data type: Economical information Notes: This is the purchased amount of bricks for production of 1 ton Hot rolled round steel billets. The brick residue is recycled back to one of the suppliers Fagerst Eldfasta, Bjuv or Höganäs.	Output	Residue	Brick	0.16			kg	Technosphere	Sweden
Data type: Economical information Notes: This is the purchased amount of dolomite for production of 1 ton Hot rolled round steel billets. The dolomite residue is deposited at the landfill within Ovako Steel land property.	Output	Residue	Dolomite	0.029			kg	Landfill ground	Sweden
Data type: Monitored data, discrete Notes: This is dust from shot blasting and grinding. The content is mostly FeO and Fe metal. The dust residue is deposited at the landfill within Ovako Steel land property.	Output	Residue	Dust	4.74			kg	Landfill ground	Sweden
Data type: Economical information Notes: This is the purchased amount of grease for production of 1 ton Hot rolled round steel billets. The grease residue is sent to a waste treatment company for destruction.	Output	Residue	Grease	0.054			kg	Technosphere	Sweden
Data type: Unspecified Notes: The hydraulic oil residue is assumed to be the same amount as the hydraulic oil input. It is sent to a waste treatment company for destruction.	Output	Residue	Hydraulic oil	0.115			l	Technosphere	Sweden
Data type: Monitored data, discrete Notes: The slag is granulate from the oxygen scarfing process. The slag residue is deposited at the landfill within Ovako Steel land property. The content of the slag (by weight-%): SiO2 0,04 MnO 0,034 P2O5 0,007 Cr2O3 1,02 NiO 0,13 MgO 0,02 CuO 0,27 V2O5 0,012 TiO2 0,004 Al2O3 0,02 FeO 75,2 CaO 0,01 Na2O 0,002 K2O 0,004 ZnO 0,01 PbO 0,003 C 0,31 S 0,009 Fe met. 23 (Iron as metal) Moist. 7,9 (Water)	Output	Residue	Slag	30.9			kg	Landfill ground	Sweden
Data type: Monitored data, discrete Notes: The sludge is from the oxygen scarfing process. The slag residue is deposited at the landfill within Ovako Steel land property. The content of the slag (by weight-%): SiO2 0,04 MnO 0,31 P2O5 0,01 Cr2O3 0,77 NiO 0,125 MgO 0,02 CuO 0,29 V2O5 0,012 TiO2 0,01 Al2O3 0,04 FeO 89,0 CaO 0,02 Na2O 0,005 K2O 0,008 ZnO 0,02 PbO 0,01 C 0,12 S 0,009 Fe met. 2,0 (Iron metal) Moist. 28,6 (Water)	Output	Residue	Sludge	9.06			kg	Landfill ground	Sweden
Data type: Monitored data, discrete Notes: The steel scrap is losses in the pit furnace, cutting, partitioning and other processes. The scrap is recycled back to the scrap yard at Ovako Steel.	Output	Residue	Steel scrap	144			kg	Technosphere	Sweden

About Inventory	
Publication	The data will be published in the Master thesis: ''LCA for the Plain Bearing GE30, Manufactured from Steel Tubes'' by Jesper Nilsson, Göteborgs Universitet/Chalmers University of Technology in 2001. -- Data documented by Jesper Nilsson, MSc thesis worker at SKF. Documentation reviewed by Karolina Flemström, IMI, Chalmers University of Technology Data published in SPINE@CPM 2002-09-09
Intended User	Suppliers and buyers of steel
General Purpose	The general purpose for this data inventory is to document data in a way suitable for LCA studies.
Detailed Purpose	The data will be used in the Master thesis: ''LCA for the Plain Bearing GE30, Manufactured from Steel Tubes'' by Jesper Nilsson, Göteborgs Universitet/Chalmers University of Technology in 2001. The reason for carrying out this LCA was to describe the environmental performances of the SKF plain bearing GE30. The main purpose was to find out which activities during the life cycle of the GE30, that contribute to most negative environmental impacts. GE30 was chosen because there already was some life cycle inventory data available for this bearing type and because it is the most sold bearing at SKF Gleitlager. The plain bearing GE30 is manufactured from cold rolled steel tubes of quality SKF3, 100Cr6. One of the activities included is production of Hot rolled round steel billets.
Commissioner	SKF Nova - Chalmers Teknikpark 412 88 Göteborg Sweden .
Practitioner	Jesper Nilsson - Nybohovsbacken 31, 4 tr 121 63 Stockholm Sweden .
Reviewer	
Applicability	The data is applicable to the production of Hot rolled round steel billets of steel quality SKF3 100Cr6 at the Rolling Mill at Ovako Steel in Hofors, Sweden. It is applicable to billets of diameter 80mm. However,since allocations have been made according to weight, the data can probably also be applicable to other Hot rolled steel tubes manufactured from 80mm Hot rolled round steel billets. The Hot rolled round steel billets are produced from steel ingots. This manufacturing step is presented as a separate data sets, see the activities about ''Production of bearing steel''.
About Data	The data is based on production data, economical information, monitoring and estimations at the Rolling Mill at Ovako Steel AB in Hofors, Sweden. All data was recieved as annual inputs and outputs for the entire Hot rolling mill.
Notes	

SPINE LCI dataset: Manufacturing of Hot Rolled Square Billets, 150 mm

Administrative	
Finished	Y
Date Completed	2000-01-14
Copyright	
Availability	Public

Technical System	
Name	Manufacturing of Hot Rolled Square Billets, 150 mm
Functional Unit	One ton of hot rolled square billet, 150 mm.
Functional Unit Explanation	
Process Type	Gate to gate
Site	Rolling Mill Ovako Steel AB 813 82 Hofors Sweden
Sector	Materials and components

Owner	Rolling Mill Ovako Steel AB 813 82 Hofors Sweden
Technical system description	The following process steps are included in the data set: 1. Pit Furnace 2. Billet rolling, stand 1 3. Oxygen scarfing 4. Billet rolling, stand 2 5. Partitioning 6. Cooling bed The raw material is ingots from the Steel mill. When the ingots are put in the pit furnace they have a temperature of about 800 degrees Celsius. 6 of the furnaces have oxyfuel technology, 6 have oil/air combustion, 1 is heated with liquefied petroleum gas. In the furnace the ingots are heated till rolling temperature which is about 1200 degrees. When the rolling temperature is reached the ingots are soaked for three hours. The ingots are rolled in 26 passes down to 220 square and are thereafter sent through the oxygen scarfing. In rolling stand 2 the ingots are rolled down to 150 mm square billets. This is the final dimension and the billets are now cut and allowed to cool in the cooling bed till maximum 100 degrees.

System Boundaries

Nature Boundary	Emission to air and water are included. These are the main emissions and they are reported to the authorities in the annual environmental report. Emissions to soil are not known and not reported to the authorities. The water recipient is Hoån.
Time Boundary	The data are based on the production in the year 1998. In the beginning of the year 2000 the dimension of the billets produced will change from 150 mm square to 145 mm square.
Geographical Boundary	The Ovako Steel rolling mill is located in Hofors, Sweden.
Other Boundaries	Production of the raw material is not included. Production of electricity is not included. Transports are not included, exept for internal transport with electrical industrial truck. Waste treatment is not included. Subsystems concearing employees are not included. Recycling of steel scrap is not included.
Allocations	First the level of detail in the system has been increased to separate the process routes. For processes where it was not possible to separate how specific types of steel influence the process, the data have been divided by the tons produced in that specific process.
Systems Expansions	not relevant

Flow Data

General Activity QMetaData

Date Conceived	1998-01-01
Data Type	Derived, mixed
Represents	Ovako Steel AB in Hofors
Method	The data are from Ovako's purchase system and environmantal reports. The level of detail has made it possible to get data for each process which have then been divided by the processed tons.
Literature Reference	Ovako Steel internal information system
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: Ovako Steel internal information system Notes: Drinking water used in the processes.	Input	Natural resource	Municipal water	0.116			m3	Ground water	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: Ovako Steel internal information system Notes: Industrial water taken from the river.	Input	Natural resource	Surface water	1.683			m3	River	Sweden

	Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	Brick	0.136			kg	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	Dolomite	0.0247			kg	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: Ovako Steel internal information system	Input	Refined resource	Electricity	54.97			kWh	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	Grease	0.0449			kg	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	Hydraulic oil	0.050			kg	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: EO3 and EO5	Input	Refined resource	Light fuel oil	0.018			m3	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	LPG	2.754			kg	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	N2	5.006			l	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	O2	23.24			m3	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	Polymers	4.32E-3			l	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Monitored data, continuous Method: weighting Literature: Ovako Steel internal information system Notes: Steel quality: SKF3, 100Cr6	Input	Refined resource	Steel ingot	1183.4			kg	Technosphere	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Output	Emission	CO2	12.54			kg	Rural air	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Method: measured Literature: Ovako Steel internal information system	Output	Emission	Dust	0.0212			g	Rural air	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Method: calculated Literature: Ovako Steel internal information system	Output	Emission	NOx	0.148			kg	Rural air	Sweden
	Date concieved: 1998-01-01 Data type: Derived, unspecified Method: calculated	Output	Emission	SO2	44.472			g	Rural air	Sweden

Literature: Ovako Steel internal information system									
	Output	Product	Hot rolled square billets, 150mm	1			tonne	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: Sent back to the supplier for recycling.	Output	Residue	Brick	0.136			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Output	Residue	Dolomite	0.0247			kg	Landfill ground	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: The oil is sent for destruction.	Output	Residue	Oil	0.0949			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Output	Residue	Other rest products	23.79			kg	Landfill ground	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Output	Residue	Slag	25.38			kg	Landfill ground	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Output	Residue	Sludge	7.59			kg	Landfill ground	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, continuous Method: weighting Literature: Ovako Steel internal information system Notes: The scrap is recycled within the plant.	Output	Residue	Steel scrap	183.4			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: Ovako Steel internal information system Notes: The water is let back to the river.	Output	Residue	Waste water	1.799			m3	River	Sweden

About Inventory

Publication	Master's thesis ''LCA on SKF's Spherical Roller Bearing 24024'' by Åsa Ekdahl, ESA-report 2001:1, Department of Environmental Systems Analysis (ESA), Chalmers University of Technology (ISSN 1400-9560) This report is available for download at ESAs web-site: http://www.esa.chalmers.se -- Data documented by: Åsa Ekdahl, M Sc. student at the dept. of Environmental Systems Analysis, Chalmers University of Technology and SKF Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	The intended users of this dat
General Purpose	The general purpose of this data inventory is documentation of data which can easily be used in LCA studies.
Detailed Purpose	The data are to be used in the study: ''LCA on SKF's Spherical Roller Bearing 24024''. The aim of the study is to descibe the environmental properties of the bearing as well as identify the processes contributing most to the environmental impact.
Commissioner	Patrik Lindroth - SKF Sverige AB SRB Medium D3s3 415 50 Göteborg .

Practitioner	Lars-Gunnar Larsson - Ovako Steel AB 813 82 Hofors Sweden .
Reviewer	
Applicability	The data are applicable to the manufacturing of 150 mm square billets at Ovako Steel in Hofors.
About Data	
Notes	Tha data have been collected by Lars-Gunnar Larsson at Ovako Steel AB under the supervision of Åsa Ekdahl.

SPINE LCI dataset: Manufacturing of Hot Rolled Steel Tubes, 70,7 x 47,5 mm

Administrative	
Finished	Y
Date Completed	2002-08
Copyright	
Availability	Public

Technical System	
Name	Manufacturing of Hot Rolled Steel Tubes, 70,7 x 47,5 mm
Functional Unit	1 ton of Hot rolled steel tubes, 70,7 x 47,5 mm
Functional Unit Explanation	The bearing steel quality is SKF3, 100Cr6. 70,7 mm is the outer diameter and 47,5 the inner diameter of the tube.
Process Type	Gate to gate
Site	Tube Mill 5 Ovako Steel AB 813 82 Hofors Sweden
Sector	Materials and components
Owner	Tube Mill 5 Ovako Steel AB 813 82 Hofors Sweden
Technical system description	The hot rolled steel tubes of diameter 70,7 x 47,5 mm are manufactured from 80 mm Hot rolled round steel billets. They are purchased from the Rolling mill at Ovako Steel and the billets are cold when they get to the Tube mill. The production of Hot rolled round steel billets is not included here, but is presented as a separate data set (see the activity about ''Manufacturing of Hot Rolled Round Steel Billets''). The steel quality is SKF3, 100Cr6. Manufacturing processes for this activity: 1. Heating in the Rotary hearth furnace 2. Centering 3. Piercing 4. Assel mill 5. Reducing mill 6. Calibrating and straightening mill 7. Cooling bed In a rotary furnace the billets are heated to rolling temperature, about 1 200°C. The centre is marked in one of the end surfaces of the billet, the billet is forced over a plug and the hole is pierced. The wall thickness of the tube is decided by rolling over a mandrel in the Assel mill. In the reducing mill, the outer diameter of the tube is determined. The next step is the calibrating and straightening mill, where the dimensions of the tube are finely adjusted. After that the tube is placed on a cooling bed. The hot rolled tubes are then directly transported to the customer or passed on for further processing. The transport is not included in this data set.

System Boundaries	
Nature Boundary	Emissions to air are considered. Emissions to soil are not known. Emissions to water are not included due to lack of data. The recipient of waste water is Hoån.

Time Boundary	The data is based on the production in 1998.
Geographical Boundary	The Tube mill is located in Hofors, Sweden.
Other Boundaries	Production of refined resources is not included. Refined resources not included: - Hot rolled round steel billets - District heating - Emulsion - Hydraulic oil - LPG Production of electricity is not included. Waste treatment is not included. Subsystems concearning employees are not included. Transports are not included. Maintenance of machinery is not included.
Allocations	Allocations have been made according to weight. The input and output data for production of all hot rolled steel tubes is divided by the total amount of produced tonnes of hot rolled steel tubes (46927 ton). This gives the amount of emissions and waste that corresponds to the production of 1 ton hot rolled steel tubes.
Systems Expansions	Not relevant

Flow Data

General Activity QMetaData

Date Conceived	1998-01-01 - 2000-02-28
Data Type	Derived, mixed
Represents	Ovako Steel AB in Hofors
Method	The data is derived, monitord and estimated by Cecilia Persson at the Tube mill at Ovako Steel AB in Hofors, Sweden.
Literature Reference	Ovako Steel internal information, obtained by Cecilia Persson at the Tube mill at Ovako Steel AB.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Data type: Derived, unspecified Notes: Data calculated by Cecilia Persson at the hot tube mill, not known how.	Input	Natural resource	Surface water	4.23			m3	River	Sweden
Data type: Derived, unspecified Notes: Data calculated by Cecilia Persson at the hot tube mill, not known how.	Input	Refined resource	District heating	36.4			kWh	Technosphere	Sweden
Data type: Derived, unspecified Notes: Data calculated by Cecilia Persson at the hot tube mill, not known how.	Input	Refined resource	Electricity	326			kWh	Technosphere	Sweden
Data type: Derived, unspecified Notes: Data calculated by Cecilia Persson at the hot tube mill, not known how.	Input	Refined resource	Emulsion	3.9			kg	Technosphere	Sweden
Data type: Monitored data, discrete	Input	Refined resource	Hot rolled round steel billets	1.069			tonne	Technosphere	Sweden
Data type: Derived, unspecified Notes: Data calculated by Cecilia Persson at the hot tube mill, not known how.	Input	Refined resource	Hydraulic oil	0.25			l	Technosphere	Sweden
Data type: Monitored data, discrete Method: The consumption of LPG is measured to 48,6 kg for production of 1 ton Hot rolled round steel billets. The energy content of LPG is 12,8 kWh/kg according to Physics Handbook. The energy content of 48,6 kg LPG therefore is 621 kWh. Literature: Physics handbook, T-8.5, 1996 Notes: LPG is Liquefied Petroleum Gas. The gas is a mixture of Propane (C3H8) and Butane (C4H10).	Input	Refined resource	LPG	621			kWh	Technosphere	Sweden

Data type: Derived, unspecified Notes: Data calculated by Cecilia Persson at the hot tube mill, not known how.	Input	Refined resource	Municipal water	0.104			m3	Technosphere	Sweden
Data type: Estimated from similarity Notes: Furnace 38 gives an emission of 20 mg CO/MJ LPG combusted. Provider of information is Cecilia Persson at the hot rolling mill.	Output	Emission	CO	0.045			kg	Rural air	Sweden
Data type: Estimated from similarity Notes: Calculated according to the carbon content in the combusted LPG.	Output	Emission	CO2	73.6			kg	Rural air	Sweden
Data type: Estimated from similarity Method: Furnace 38 gives an emission of 50 mg NOx/MJ LPG combusted. Provider of information is Cecilia Persson at the hot rolling mill.	Output	Emission	NOx	0.112			kg	Rural air	Sweden
Data type: Unspecified Notes: Provided by Cecilia Persson at the hot rolling mill.	Output	Emission	Waste water	4.33			kg	River	Sweden
Data type: Monitored data, discrete	Output	Product	Hot rolled steel tube	1			tonne	Technosphere	Sweden
Data type: Derived, unspecified Notes: Data calculated by Cecilia Persson at the hot tube mill, not known how. The emulsion residue is sent to a waste treatment company for destruction.	Output	Residue	Emulsion	3.9			kg	Technosphere	Sweden
Data type: Derived, unspecified Notes: Data calculated by Cecilia Persson at the hot tube mill, not known how. The oil residue is sent to a waste treatment company for destruction.	Output	Residue	Oil	0.3			kg	Technosphere	Sweden
Data type: Derived, unspecified Notes: Data calculated by Cecilia Persson at the hot tube mill, not known how. The slag residue is deposited at the landfill within the Ovako Steel land property.	Output	Residue	Slag	22.7			kg	Technosphere	Sweden
Data type: Derived, unspecified Notes: Data calculated by Cecilia Persson at the hot tube mill, not known how. The steel scrap is recycled back to the scrap yard at Ovako Steel.	Output	Residue	Steel scrap	53			kg	Technosphere	Sweden

About Inventory	
Publication	The data will be published in the Master thesis: ''LCA for the Plain Bearing GE30, Manufactured from Steel Tubes'' by Jesper Nilsson, Göteborgs Universitet/Chalmers University of Technology in 2001. --- Data documented by Jesper Nilsson, MSc thesis worker at SKF. Documentation reviewed by Karolina Flemström, IMI, Chalmers University of Technology Data published in SPINE@CPM 2002-09-09
Intended User	Suppliers and buyers of steel
General Purpose	The general purpose for this data inventory is to document data in a way suitable for LCA studies.
Detailed Purpose	The data will be used in the Master thesis: ''LCA for the Plain Bearing GE30, Manufactured from Steel Tubes'' by Jesper Nilsson, Göteborgs Universitet/Chalmers University of Technology in 2001. The reason for carrying out this LCA was to describe the environmental performances of the SKF plain bearing GE30. The main purpose was to find out which activities during the life cycle of the GE30, that contribute to most negative environmental impacts. GE30 was chosen because there already was some life cycle inventory data available for this bearing type and because it is the most sold bearing at SKF Gleitlager. The plain bearing GE30 is manufactured from cold rolled steel tubes of quality SKF3, 100Cr6. One of the activities included is production of Hot rolled steel tubes.
Commissioner	SKF Nova - Chalmers Teknikpark 412 88 Göteborg Sweden .
Practitioner	Jesper Nilsson - Nybohovsbacken 31, 4 tr 121 63 Stockholm Sweden .
Reviewer	

Applicability	The data is applicable to the production of Hot rolled steel tubes of steel quality SKF3 100Cr6 at the Tube Mill at Ovako Steel in Hofors, Sweden. It is applicable to tubes of outer and inner diameters of 70,7 and 47,5 mm respectively. However, since allocations have been made according to weight, the data can probably also be applicable to other Hot rolled steel tubes manufactured from 80 mm Hot rolled round steel billets. This presumes that the tubes go through the same manufacturing processes, see Function for manufacturing processes for this activity. The hot rolled steel tubes have gone through several manufacturing steps at the Ovako Steel factory in Hofors. These steps are all presented as separate data sets, see the activities about: 1. ''Production of bearing steel'' 2. ''Manufacturing of Hot Rolled Round Steel Billets''
About Data	The data is derived, monitord and estimated by Cecilia Persson at Tube mill 5 at Ovako Steel AB in Hofors, Sweden. All data was recieved as annual inputs and outputs for the entire Hot rolling mill.
Notes	

SPINE LCI dataset: Manufacturing of plywood boxes at Nefab in Alfta

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Manufacturing of plywood boxes at Nefab in Alfta
Functional Unit	1 kg plywood box
Functional Unit Explanation	1 kg of the plywood box: NEFAB ExPak type-S, 1160 x 1160 x H). The whole plywood box weighs 52,61 kg. Thus all data must be multiplied with 52,61 in order to obtain the total environmental impact for one whole box.
Process Type	Gate to gate
Site	Nefab Emballage ABNordgrens väg 5 822 92 ALFTA SWEDEN
Sector	Construction
Owner	Nefab Emballage ABNordgrens väg 5 822 92 ALFTA SWEDEN
Technical system description	This activity describes a process step included in the system ''Production of plywood boxes'' , also available in the SPINE@CPM database. Plywood boxes are used to pack the coated and non-coated roller bearings from SKF, Göteborg, during the transportation to customers. The plywood boxes are manufactured by Nefab Emballage AB in Alfta, Sweden. The plywood boxes consist of plywood, steel strips, steel nails and wooden splits. The plywood boxes consist of the following parts: Contents per box Weight (kg) % of total weight Plywood 33.9 64.44 Wooden splits 14.9 28.32 Steel strips 3.7 7.03 Steel nails 0.108 0.21 Manufacturing of plywood boxes at Nefab in Alfta: At Nefab Emballage AB in Alfta the plywood box is mounted, from its ingoing parts: Plywood, Steel strips, Wooden splits and steel nails. The used data refers to an EPD from Nefab Emballage AB for the product NEFAB Expak [Environmental Product Declaration from NEFAB Emballage AB; Doc.no.5-073-103.]. The environmental profile includes emissions from local energy use and internal transportation. The presumed product in the EPD contains plywood (87%) and steel strip (13%).

	The boxes that are used by SKF contains Plywood (1877,6 g ~ 71,01%) and Steelstrip (766,5 g ~ 28,99%).

System Boundaries

Nature Boundary	Emissions to air and water are included. The inputs: plywood, steel nails, steel strips and wooden splits are considered non-elementary from the technosphere, but these inflows should be followed from the cradle with activities from the SPINE@CPM database: * Production of plywood * Virgin steel production * Hot rolling of steel sheet * Pickled hot rolled steel sheet * Cold reducing of steel sheets * Metal coating ofcold reduced steel sheets * Production of wood See more detailed information in the activity ''Production of plywood boxes''
Time Boundary	The dataset is based on an EPD made at Nefab Emballage AB during the year 1997.
Geographical Boundary	The process takes place at Nefab Emballage AB in Alfta, Sweden.
Other Boundaries	The production of electricity, diesel and oil is NOT included in this dataset but must be followed from the cradle in order to calculate the total environmental impact from this activity.
Allocations	Allocations are made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	Ovako Steel AB in Hofors
Method	The used data refers to an EPD from Nefab Emballage AB for the product NEFAB Expak [Environmental Product Declaration from NEFAB Emballage AB; Doc.no.5-073-103.]. The environmental profile includes emissions from local energy use and internal transportation. The presumed product in the EPD contains plywood (87%) and steel strip (13%). The data is recalculated to be valid for the specific product Nefab ExPak type-S, 1160 x 1160 x H, which also includes steel nails and wooden splits. The plywood box consists of the following parts: Contents per box Weight (kg) % of total weight Plywood 33.9 64.44 Wooden splits 14.9 28.32 Steel strips 3.7 7.03 Steel nails 0.108 0.21 The data from NEFAB was for plywood and steel strip = 100 %. In this specific box the plywood and steel strips = 71.47 %, thus the values from the EPD is multiplied with 0.7147.
Literature Reference	Environmental Product Declaration from NEFAB Emballage AB; Doc.no.5-073-103.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Diesel	0.0715			MJ	Technosphere	
Notes: The energy carrier was called Electricity, Swedish average in LCAiT 3.	Input	Refined resource	Electricity	0.629			MJ	Technosphere	
	Input	Refined resource	Oil	0.0143			MJ	Technosphere	
	Input	Refined resource	Plywood	0.644			kg	Technosphere	
	Input	Refined resource	Renewable fuel	0.107			MJ	Technosphere	
	Input	Refined resource	Steel nails	0.00205			kg	Technosphere	Sweden
	Input	Refined resource	Steel strips	0.07			kg	Technosphere	
	Input	Refined resource	Wooden splits	0.2832			kg	Technosphere	Sweden
Notes: Waste	Output	Emission	Ashes	0.1072			g	Air	
	Output	Emission	CO	0.043			g	Air	

Notes: Air	Output	Emission	CO2	14.39			g	Air	
	Output	Emission	Hydrocarbons	0.0143			g	Air	
	Output	Emission	NOx	0.164			g	Air	
	Output	Emission	Particles	0.0071			g	Air	
	Output	Emission	SO2	0.0143			g	Air	
	Output	Emission	VOC	0.0286			g	Air	
	Output	Product	plywood box	1			kg	Technosphere	
Notes: (to licensed custody)	Output	Residue	Hazardous waste	2.995			g	Technosphere	
Notes: (to comb. in heating plant)	Output	Residue	Industrial	7.304			g	Technosphere	
Notes: (to conversion)	Output	Residue	Steel	15.45			g	Technosphere	
Notes: (to comb. in heating plant)	Output	Residue	Wood	78.47			g	Technosphere	

About Inventory	
Publication	Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. Both types of bearings are packed in a plywood box. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for the manufacturing of the plywood box: Nefab ExPak type-S, 1160 x 1160 x H, at Nefab Emballage AB in Alfta, Sweden. The plywood box consists of the following parts: Contents per box Weight (kg) % of total weight Plywood 33.9 64.44 Wooden splits 14.9 28.32 Steel strips 3.7 7.03 Steel nails 0.108 0.21 Note that the production of steel, plywood and wood is not taken into account in this activity. The total impact for producing one plywood box of this type can be seen in the activity ''Production of plywood boxes'' in the SPINE@CPM database.
About Data	The used data refers to an EPD from Nefab Emballage AB for the product NEFAB Expak [Environmental Product Declaration from NEFAB Emballage AB; Doc.no.5-073-103.]. The environmental profile includes emissions from local energy use and internal transportation. The presumed product in the EPD contains plywood (87%) and steel strip (13%). The data is recalculated to be valid for the specific product Nefab ExPak type-S, 1160 x 1160 x H, which also includes steel nails and wooden splits.
Notes	

SPINE LCI dataset: Manufacturing of polyurethane insulation

Administrative	
Finished	Y
Date Completed	1996-03-01

Copyright	
Availability	Public

Technical System

Name	Manufacturing of polyurethane insulation
Functional Unit	pcs
Functional Unit Explanation	1 pcs of insulation. In the production 47,8% of the insulation pieces are shaped as blocks and 52,2% as pipes. The annual production of 1995 was 132 pcs of insulation blocks and 144 pcs of culvert pipes.
Process Type	Gate to gate
Site	Puritanus Teknik AB Box 2070 433 02 Partille Sweden
Sector	Materials and components
Owner	Puritanus Teknik AB Box 2070 433 02 Partille Sweden
Technical system description	The company manufactures polyurethane insulation. The insulation is shaped as blocks or pipes. One dosage machine is used, PUR Hennecke HK 135. The casting is done in secluded units where the material is injected from the mixing head to the unit through a hole, which is sealed after the filling is done.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified
Represents	Ovako Steel AB in Hofors
Method	Studing the Environmental report from Puritanus Teknik AB for 1995 The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1995, which was 132 pcs of insulation blocks and 144 pcs of culvert pipes, which totals to 276 insulation pieces.
Literature Reference	Environmental Product Declaration from NEFAB Emballage AB; Doc.no.5-073-103.
Notes	The data type unspecified implies that one does not know the origin of the data. The enterprise is new and the production is quite low, compared to their limit (400 ton insulation components of polyurethane), but they have plans to expand it further. Then it might be relevant to check up on the emission of MDA and hydrocarbons as well.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Fuel oil	0.0543			m3	Technosphere	
	Input	Refined resource	Isocyanate	1.88			kg	Technosphere	
	Input	Refined resource	Polyol	1.45			kg	Technosphere	

Date concieved: 1995 Method: The mehtod is to measure the absorbtion of MD1 (isocyanate) in a absorption solvent, which is analysed at a laboratory (KM Miljöteknik AB, Box 331, 401 25 Göteborg, Sweden, Phone: +46 -31 7714900, Fax: +46 -31 802857). An air flow is led through the solvent where the contamination is absorbed. After analyse, the content is multiplied with the amount of air that has passed through the absorption solvent.	Output	Emission	Isocyanate	1.88			mg	Air	
Notes: Consists of polyurethane insulation, disposed by Ragnsell	Output	Residue	Industrial waste	0.109			kg	Technosphere	

About Inventory	
Publication	The Environmental report from Puritanus Teknik AB for 1995, The Board of County in Göteborg and Bohus -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden.
Practitioner	Söderberg, Ramon VD - Puritanus Teknik AB Box 2070 433 02 Partille Sweden.
Reviewer	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden
Applicability	The function of the technical system is not sufficently described. Contact the company to get the necessary details. The enterprise is new and the production is quite low, compared to their limit (400 ton insulation components of polyurethane), but they have plans to expand it further. Then it might be relevant to check up on the emission of MDA and hydrocarbons as well.
About Data	
Notes	

SPINE LCI dataset: Manufacturing of SKF’s Spherical Roller Bearing

Administrative	
Finished	Y
Date Completed	2000-01-18
Copyright	
Availability	Public

Technical System	
Name	Manufacturing of SKF’s Spherical Roller Bearing
Functional Unit	One spherical roller bearing 24024
Functional Unit Explanation	The SRB 24024 is manufactured in production line 4 at the D-factory. It weights 5,40 kg and consists of one outer ring, one inner ring, one guide ring, two cages and 52 rollers.

Process Type	Gate to gate
Site	D-Factory SKF Sverige AB 415 50 Göteborg Sweden
Sector	Consumer goods
Owner	D-Factory SKF Sverige AB 415 50 Göteborg Sweden
Technical system description	The following process steps are included in the data set: 1. Turning 2. Polishing 3. Assembly 4. Rust treatment 5. Packing Besides the above electrified trucks used for internal transports are included. At the SKF D-factory in Göteborg the inner and outer rings are turned, polished and put together with the guide ring, the two cages and the 52 rollers to produce a spherical roller bearing, 24024. The complete bearing is treated with rust preservatives and packed in flow film and a corrugated board box.

System Boundaries

Nature Boundary	Emissions to air and water are not included due to that the emissions that are regarded to be negligeble.
Time Boundary	Most of the data are taken from a waste inventory made in 1997 and based on data for 1996.
Geographical Boundary	The plant is located in Göteborg, Sweden.
Other Boundaries	Transport are not considered except for internal transports carried out by electrical industrial trucks. Subsystems concearning emplyees are not included.
Allocations	The data are allocated according to a distribution key wich is used at SKF to distribute the economic responsibility for waste treatment etc. According to the key SRB Medium stands for 70% of the wastes and the production line 4 stands for 11.62% of these 70 % at the SKF D-factory
Systems Expansions	not relevant

Flow Data

General Activity QMetaData

Date Conceived	1996-01-01
Data Type	Derived, unspecified
Represents	Ovako Steel AB in Hofors
Method	For all the waste categories the data have been calculated from the ''Avfallssammanställning'' see litterature referens below, using the distribution key described under ''Allocation''. The resources are taken from the SKF purchase system and then calulated according to the distribution key described under ''Allocation''.
Literature Reference	SKF internal information system, Miljöinventering, Avfallssammanställning för SKF Sverige AB 1997-09-12 utförd av AF-IPK.
Notes	The data are partly from 1996 and partly from 1998.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: SKF internal information system Notes: Production line 4 uses 0,01386 l for turning one pair of rings.	Input	Refined resource	Cutting fluid	0.0301			l	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: SKF internal information system Notes: For heating of the factory.	Input	Refined resource	District heating	4.854			kWh	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: SKF internal information system	Input	Refined resource	Electricity	6.983			kWh	Technosphere	Sweden

Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: SKF internal information system	Input	Refined resource	Hydraulic oil	0.0233			l	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: SKF internal information system Notes: This includes washing fluid and anti-corrosive treatment.	Input	Refined resource	Mineral oil products	31.68			g	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: SKF internal information system	Input	Refined resource	Natural gas	0.239			m3	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: SKF internal information system	Input	Refined resource	Polishing Oil	0.00601			l	Technosphere	Sweden
Date concieved: 1999-01-01 Data type: Monitored data, continuous Method: weighting Literature: SKF internal information system Notes: Guide ring to the bearing made from PNC-30, powder steel that is sintered.	Input	Refined resource	Sintered Steel Ring	0.086			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, continuous Method: weighting Literature: SKF internal information system Notes: The bearing is made up by two cages which each weigh 0.1238 kg.	Input	Refined resource	Steel cage	0.2476			kg	Technosphere	Sweden
Date concieved: 1999-01-01 Data type: Monitored data, continuous Method: weighting Literature: SKF internal information system Notes: Inner ring to the bearing, manufactured in France. The steel is 100Cr6, SKF 3.	Input	Refined resource	Steel ring	2.58			kg	Technosphere	Sweden
Date concieved: 1999-01-01 Data type: Monitored data, continuous Method: weighting Literature: SKF internal information system Notes: Outer ring to the bearing, produced at Ovako Steel in Hofors. The steel is 100Cr6, SKF3.	Input	Refined resource	Steel ring	3.38			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, continuous Method: weighting Literature: SKF internal information system Notes: The bearing contains 52 rollers each weighing 0.0294 kg.	Input	Refined resource	Steel roller	1.5288			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, continuous Method: weighting Literature: SKF internal information system Notes: The bearing consists of one outer ring, one inner ring, one guide ring, two cages and 52 rollers, rust preservatives etc.	Output	Product	Spherical Roller Bearing	5.40			kg	Technosphere	Sweden
Date concieved: 1996-01-01 Data type: Monitored data, discrete Literature: Miljöinventering, Avfallssammanställning för SKF Sverige AB 1997-09-12 utförd av AF-IPK. Notes: Includes corrugated board and carton.	Output	Residue	Board	0.016			kg	Technosphere	Sweden
Date concieved: 1996-01-01 Data type: Monitored data, discrete Literature: Miljöinventering, Avfallssammanställning för SKF Sverige AB 1997-09-12 utförd av AF-IPK.	Output	Residue	Emulsion	0.500			l	Technosphere	Sweden
Date concieved: 1996-01-01 Data type: Monitored data, discrete Literature: Miljöinventering, Avfallssammanställning för SKF Sverige	Output	Residue	Grease	0.4072			g	Technosphere	Sweden

AB 1997-09-12 utförd av AF-IPK.									
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: SKF's internal information system Notes: The dust is pressed to briquettes and transported to Ovako Steel in Hofors for recycling. The material is stelle 100Cr6, SKF 3.	Output	Residue	Grinding dust	0.413			kg	Technosphere	Sweden
Date concieved: 1996-01-01 Data type: Monitored data, discrete Literature: Miljöinventering, Avfallssammanställning för SKF Sverige AB 1997-09-12 utförd av AF-IPK. Notes: 0,0727 kg is combustible, while 0,0329 kg is not.	Output	Residue	Industrial waste	0.1056			kg	Technosphere	Sweden
Date concieved: 1996-01-01 Data type: Monitored data, discrete Literature: Miljöinventering, Avfallssammanställning för SKF Sverige AB 1997-09-12 utförd av AF-IPK. Notes: polishing oil	Output	Residue	Mineral oil products	0.00913			l	Technosphere	Sweden
Date concieved: 1996-01-01 Data type: Monitored data, discrete Literature: Miljöinventering, Avfallssammanställning för SKF Sverige AB 1997-09-12 utförd av AF-IPK. Notes: Mixed paper.	Output	Residue	Other paper	0.0101			kg	Technosphere	Sweden
Date concieved: 1996-01-01 Data type: Monitored data, continuous Literature: Miljöinventering, Avfallssammanställning för SKF Sverige AB 1997-09-12 utförd av AF-IPK. Notes: Transported to Ovako Steel in Hofors for recycling. Material: steel 100Cr6, SKF 3. This includes both grindings 1.727 kg and cassations 0,413 kg.	Output	Residue	Steel scrap	2.14			kg	Technosphere	Sweden
Date concieved: 1996-01-01 Data type: Monitored data, discrete Literature: Miljöinventering, Avfallssammanställning för SKF Sverige AB 1997-09-12 utförd av AF-IPK. Notes: The waste water is alkalic.	Output	Residue	Waste water	0.0166			kg	Technosphere	Sweden
Date concieved: 1996-01-01 Data type: Monitored data, discrete Literature: Miljöinventering, Avfallssammanställning för SKF Sverige AB 1997-09-12 utförd av AF-IPK.	Output	Residue	Wood products	0.020			kg	Technosphere	Sweden

About Inventory

Publication	Master's thesis ''LCA on SKF's Spherical Roller Bearing 24024'' by Åsa Ekdahl, ESA-report 2001:1, Department of Environmental Systems Analysis (ESA), Chalmers University of Technology (ISSN 1400-9560) This report is available for download at ESAs web-site: http://www.esa.chalmers.se -- Data documented by: Åsa Ekdahl, M Sc. student at the dept. of Environmental Systems Analysis, Chalmers University of Technology and SKF Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	The intended users are LCA pra
General Purpose	The general purpose is an LCA study on SKF.
Detailed Purpose	The data are to be used in the study: ''LCA on SKF's Spherical Roller Bearing 24024''. The aim of the study is to descibe the environmental properties of the bearing as well as identify the processes contributing most to the environmental impact.
Commissioner	Patrik Lindroth - SKF Sverige AB SRB Medium D3s3 415 50 Göteborg .
Practitioner	Åsa Ekdahl - SKF Sverige AB 415 50 Göteborg Sweden .
Reviewer	
Applicability	The data are applicable to SKF' spherical roller bearings manufactured on production line 4 at the D-factory in Göteborg.

About Data	
Notes	

SPINE LCI dataset: Manufacturing of the Plain bearing GE30

Administrative	
Finished	Y
Date Completed	2002-08
Copyright	
Availability	Public

Technical System	
Name	Manufacturing of the Plain bearing GE30
Functional Unit	1 ton Plain bearings GE30
Functional Unit Explanation	1 ton Plain bearings GE30 corresponds to 6250 pieces. The plain bearing GE30 is composed by one inner and one outer ring. The inner and outer rings are manufactured from Cold rolled round steel tubes with outer diameters of 41,55 and 47,75 mm and inner diameters of 37,2 and 41 mm respectively. The steel quality is SKF3 100Cr6
Process Type	Gate to gate
Site	SKF Gleitlager GmbH Postfach 3020 663 40 Püttlingen GERMANY
Sector	Machinery and equipment
Owner	SKF Gleitlager GmbH Postfach 3020 663 40 Püttlingen GERMANY
Technical system description	The plain bearing GE30 is composed by one inner and one outer ring. The inner and outer rings are manufactured from Cold rolled round steel tubes with outer diameters of 41,55 and 47,75 mm and inner diameters of 37,2 and 41 mm respectively. The tubes are purchased from Ovako Steel AB in Hofors, Sweden and transported to Püttlingen by heavy truck and ferry. Neither the transports or the production of the tubes are included here. The production of the tubes is presented as a separate data set (see the activity about ''Manufacturing of Cold Rolled Steel Tubes''). These process steps are included in the data set: 1. Turning 2. Drilling 3. Washing 4. Heat treatment 5. Grinding 6. Manganese phosphating 7. Assembly 8. Preparation 9. Sealing 10. Inspection 11. Packaging 1. In the turning process a lot of neat cutting oil (ECOCUT 3032 LE) is applied on the tube surfaces continuously. Not all of the oil is collected properly, some of it ends up on the plant floor. The plant floor is therefor once a week filled with wood chips, which absorb the cutting oil The wood chips are collected and sent to a district heating plant for combustion. The collected cutting oil goes together with the turning chips to an oil separator. In the oil separator the turning chips are separated from the cutting oil in three different mechanical filters. The cutting oil is used again for turning and the turning chips are recycled by a steel scrap recycling company. Some of the oil also follows the exhaust gases into the fan system. In the fan system the off gases first are cleaned with condensing and then with an electrostatic filter.

	2. The next step in the production process is drilling and deepering. The reason for the drilling is that two lubrication holes are needed in the GE30 for bearing maintenance during the use. The bearings are lubricated during its use to reduce friction between the bearing surfaces and to extend the bearing lifetime. The deepening of the surface of the inner ring is for keeping the lubrication oil between the outer and inner ring. The drilling chips are collected and transported to the steel briquetting industry together with the turning chips and the grinding sludge. During the drilling a coolant (ECOCOOL SCIP) is added for the process. After separation from the drilling chips, the coolant is recycled and used again. This activity is not quantified for the study. 3. After drilling the rings pass on to the washing, water and chemicals are added into the washing tank. The outputs of this activity are mist extraction, water emissions and oil waste. The water goes to the distillation plant and after the plant the concentrate will be waste oil and the distillate will mostly be water, which is used in the surface treatment (phosphating). The oil waste goes to oil separation and is then used again. 4. In the first step of the heat treatment the rings are heated up to about 180ºC by combustion of natural gas. Then the rings are put in an oil bath for cooling; that is the hardening. The temperature of the quench oil (Isorapid 277 E) in the bath has to be held at about 70 ºC continuously. Therefor the oil bath is connected to an oil tank with thermostat and cooling system and the quench oil is then circulated between the bath and the tank. At the bottom of the oil tank sludge is formed, which is removed two times a year. The sludge is transported to a power plant for combustion. To remove the quench oil from the rings they are washed with water. But in order to prevent the rings from corrosion an anticorrit (P3-neutracare ®400) has to be added to the washing water. The used washing water goes to a vacuum vaporizator where the water is separated from the oil. For description of how the vacuum vaporizator works and where the wastewater and waste oil go see ''Cleaning systems and recycling''. After the washing the rings are dried with Nitrogen gas at a temperature of 140-150 ºC, before they are cooled down with air. At all process steps the exhaust gases are led out through the roof without any cleaning. 5. Grinding stones are used together with a coolant, consistent of 95% water and 5% of the mineral oil Ecocool 1700 S. The grinding waste is dewatered in a press and then the grinding sludge is transported to the metal briquetting industry together with the turning and drilling waste. The water is transported to the central water tank. 6. In order for the plain bearings to maintain the same properties until they are put in use their surfaces have to be protected. Therefor they are manganese phosphated in a multiple process, where a lot of chemicals are involved and therefor the environmental load is clearly significant. The process gives air and water emissions as well as waste sludge and wastewater. 7. The next step is the assembly, where the outer ring is split and the inner ring is pressed into the outer. 8. Preparation: Some of the bearings are Molycote plated at the outer rings inner surface and others are applied with rubbing in oil. This activity is not quantified for the study. 9 & 10. The bearings are sealed and inspected before sent to packaging. 8. The last step is the packaging and the packaging procedures for the GE30 are as follows: - 50% in single pack (54x24x54 mm). - 35% in cassettes with 60 bearings in each (269x182x84 mm). - 15% in bulks with 10 parts in each (115x115x52 mm). The single packaged bearings are first put in a plastic bag and then in a paper box. The bearing type and brand is printed on the box with thermotransfer printer foil. The cassettes are recycled and the bulks are plastics. This means that the packaging of each plain bearing in average requires half of a single pack box and 1,5% of a bulk. After packaging all plain bearings are sent to Schweinfurt and then straight to customers or to Brussels, where they keep stocks of bearings. This activity is not quantified for the study because it is considered to be of very little environmental significance to the result.

System Boundaries	
Nature Boundary	Emissions to air are considered. Emissions to soil are not included due to lack of data. Emissions to water are not included due to lack of data. The waste water is sent to the communal wastewater treatment plant.
Time Boundary	The data is based on the production in 1998.
Geographical Boundary	The production plant is located in Püttlingen, Germany.
Other Boundaries	Production of refined resources is not included. Refined resources not included not included: - Cold rolled steel tube - H_2SO_4 - HCl - Light fuel oil - N_2 - $NaHSO_3$

	- NaOH - Natural gas - Wood chips - Cutting oil - Quench oil Production of electricity is not included. Waste treatment is not included. Subsystems concearning employees are not included. Transports are not included.
Allocations	Energy and water consumption for the entire SKF Gleitlagerplant are representative for the production of plain bearings, rod ends and bushings. It has not been possible to separate the data for the three different products. For allocation of this data the turnover has been used as base. Production of all plain bearings stand for 75 % of the total turnover and it is assumed that they stand for 75 % of this energy and water consumption. The data that is specific for plain bearing production has been allocated by input weight of all the steel tubes used for plain bearing production. 1998 the total input weight of tubes for plain bearing production was 1 943 182 kg. The total weight of tubes for production of GE30:s was 65 802 kg which corresponds to 3,39 %.
Systems Expansions	Not relevant

Flow Data

General Activity QMetaData

Date Conceived	1998-01-01 - 2000-02-28
Data Type	Derived, mixed
Represents	SKF Gleitlager in Püttlingen, Germany
Method	The data is based on production data at the production plant at SKF Gleitlager in Püttlingen, Germany. Emission data is all monitored by authorised companies, except for CO2 emissions that are derived from the carbon content in the combusted fuel.
Literature Reference	SKF Gleitlager internal information as recived from Peter Spengler at SKF Gleitlager in Püttlingen, Germany.
Notes	The data are partly from 1996 and partly from 1998.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Data type: Unspecified	Input	Natural resource	Fossil water	3509			l	Ground water	Germany
Data type: Unspecified Notes: Taken from nearby river	Input	Natural resource	Surface water	1612			l	River	Germany
	Input	Refined resource	Cold rolled steel tube	1.958			tonne	Technosphere	Germany
Data type: Economical information Notes: Purchased amount.	Input	Refined resource	Cutting oil	8.7			kg	Technosphere	Germany
Data type: Economical information Notes: Purchased amount.	Input	Refined resource	Electricity	5867			kWh	Technosphere	Germany
Data type: Economical information Notes: Purchased amount.	Input	Refined resource	H2SO4	806			ml	Technosphere	Germany
Data type: Economical information Notes: Purchased amount.	Input	Refined resource	HCl	60			ml	Technosphere	Germany
Data type: Economical information Notes: Purchased amount.	Input	Refined resource	Light fuel oil	18			kg	Technosphere	Germany
Data type: Unspecified	Input	Refined resource	N2	254			m3	Technosphere	Germany
Data type: Economical information Notes: Purchased amount.	Input	Refined resource	NaHSO3	242			ml	Technosphere	Germany
Data type: Economical information Notes: Purchased amount.	Input	Refined resource	NaOH	181			ml	Technosphere	Germany
Data type: Economical information Method: The consumption of Natural gas is calculated to 430,4 kg for production of 1 ton plain bearings GE30. The energy content of Natural gas (95% Methane) is 14,3 kWh/kg, according to Physics Handbook. The energy content of 430,4 kg Light fuel oil therefore is 6155 kWh. Literature: Physics handbook, T-8.5, 1996 Notes: Purchased amount.	Input	Refined resource	Natural gas	6155			kWh	Technosphere	Germany

Data type: Economical information Notes: Purchased amount.	Input	Refined resource	Quench oil	6.6			kg	Technosphere	Germany
Data type: Unspecified Notes: wood chips from nearby sawmill.	Input	Refined resource	Wood chips	5			kg	Technosphere	Germany
	Output	Emission	CO	0.44			kg	Rural air	Germany
	Output	Emission	CO2	1229			kg	Rural air	Germany
Data type: Estimated from similarity Notes: Estimated to be the same as input quantity of N2.	Output	Emission	N2	254			m3	Rural air	Germany
	Output	Emission	NOx	1.17			kg	Rural air	Germany
	Output	Emission	SO2	79			g	Rural air	Germany
Data type: Monitored data, discrete Notes: This waste water goes to communal water cleaning plant 200 m from the main plant. Measurements two times a year are carried out by authorized company (S.A.F.E. Analytik GmbH). Water content: pH 9,09 Moodity 416 mS/m Dichloridmethane <0,01mg/l 1,1,1 - Trichloridethane <0,0001mg/l Trichloridethen <0,0001 mg/l Tetrachloridethen <0,0001mg/l Cl- <0,05 mg/l Cr6 <0,02 mg/l Sulfide <0,02 mg/l Hydrocarbons 0,75 mg/l AOX 0,015 mg/l Pb 0,009 mg/l Cd 0,007 mg/l Cr 0,058 mg/l Cu 0,004 mg/l Ni 0,048 mg/l Sn 0,011 mg/l	Output	Emission	Waste water	4156			l	Technosphere	Germany
Data type: Unspecified Notes: This is rain water from the entire site area and it goes into nearby river.	Output	Emission	Water	965			l	River	Germany
	Output	Product	Plain Bearing GE30	1			tonne	Technosphere	Germany
Data type: Estimated from similarity Notes: Estimated to be the same as input quantity of cutting oil. The cutting oil is sent to the oil separator at the factory and recycled to be used again.	Output	Residue	Cutting oil	8.7			kg	Technosphere	Germany
Data type: Unspecified Notes: The grinding waste is dewatered in a press and then the grinding sludge is sent to the metal briquetting industry for recycling.	Output	Residue	Grinding sludge	176			kg	Technosphere	Germany
Data type: Unspecified Notes: The hazardous waste is sent to a waste treatment company for destruction.	Output	Residue	Hazardous waste	81			g	Technosphere	Germany
Data type: Unspecified	Output	Residue	Industrial waste	49			kg	Technosphere	Germany
Data type: Unspecified	Output	Residue	Machining sludge	6.2			kg	Technosphere	Germany
Data type: Unspecified Notes: The mixed oils are sent to a waste treatment company for destruction.	Output	Residue	Mixed oils	24			kg	Technosphere	Germany
Data type: Unspecified Notes: The mixed steel scrap is sent to a local scrap dealer for recycling.	Output	Residue	Mixed steel scrap	46			kg	Technosphere	Germany
Data type: Unspecified Notes: The painting sludge is sent to a waste treatment company for destruction.	Output	Residue	Painting sludge	227			g	Technosphere	Germany
Data type: Unspecified	Output	Residue	Phosphating sludge	11			kg	Technosphere	Germany
Data type: Estimated from similarity Notes: Estimated to be the same as input quantity of quench oil. The quench oil is sent to the oil separator at the factory and recycled to be used again.	Output	Residue	Quench oil	6.6			kg	Technosphere	Germany
Data type: Unspecified	Output	Residue	Sodium nitrite	38			g	Technosphere	Germany
Data type: Derived, unspecified Notes: The solid steel scrap is sent to a local scrap dealer for recycling.	Output	Residue	Solid steel scrap	123			kg	Technosphere	Germany
Data type: Derived, unspecified Notes: The steel chips are sent to the metal briquetting industry for recycling.	Output	Residue	Steel chips	854			kg	Technosphere	Germany

Data type: Unspecified Notes: The waste paper is sent to a waste treatment company for destruction.	Output	Residue	Waste paper	29			kg	Technosphere	Germany
Data type: Unspecified Notes: The wood chips are sent to a waste treatment company for destruction.	Output	Residue	Wood chips	5.0			kg	Technosphere	Germany

About Inventory	
Publication	The data will be published in the Master thesis: ''LCA for the Plain Bearing GE30, Manufactured from Steel Tubes'' by Jesper Nilsson, Göteborgs Universitet/Chalmers University of Technology in 2001. -- Data documented by Jesper Nilsson, MSc thesis worker at SKF. Documentation reviewed by Karolina Flemström, IMI, Chalmers University of Technology Data published in SPINE@CPM 2002-09-09
Intended User	Suppliers and buyers of the SK
General Purpose	The general purpose for this data inventory is to document data in a way suitable for LCA studies.
Detailed Purpose	The data will be used in the Master thesis: ''LCA for the Plain Bearing GE30, Manufactured from Steel Tubes'' by Jesper Nilsson, Göteborgs Universitet/Chalmers University of Technology in 2001. The plain bearing GE30 is manufactured from cold rolled steel tubes of quality SKF3, 100Cr6. The reason for carrying out this LCA was to describe the environmental performances of the SKF plain bearing GE30. The main purpose was to find out which activities during the life cycle of the GE30, that contribute to most negative environmental impacts. GE30 was chosen because there already was some life cycle inventory data available for this bearing type and because it is the most sold bearing at SKF Gleitlager.
Commissioner	SKF Nova - Chalmers Teknikpark 412 88 Göteborg Sweden .
Practitioner	Jesper Nilsson - Nybohovsbacken 31, 4 tr 121 63 Stockholm Sweden .
Reviewer	
Applicability	The data is applicable to the production of the plain bearing GE30 at SKF Gleitlager in Püttlingen, Germany. The bearings are manufactured from Cold rolled steel tubes. In 1999 SKF Gleitlager purchased the cold rolled steel tubes from Ovako Steel AB in Hofors, Sweden. The steel quality of the tubes were SKF3, 100Cr6. However, steel tubes from other manufacturers and different steel quality have been used before and might be used in the future. The production process of the plain bearing GE30 at SKF Gleitlager is about the same regardless of the steel tube manufacturer. Therefore the data is not only applicable to production of plain bearings from cold rolled steel tubes manufactured from Ovako Steel, but also to production of plain bearings from steel tubes from other manufacturers. The cold rolled steel tubes from Ovako Steel have gone through several manufacturing steps at the Ovako Steel factory in Hofors. These steps are all presented as separate data sets, see the activities about: 1. ''Production of bearing steel'' 2. ''Manufacturing of Hot Rolled Round Steel Billets'' 3. ''Manufacturing of Hot Rolled Steel Tubes'' 4. ''Manufacturing of Cold Rolled Steel Tubes''
About Data	The data is based on production data at the production plant at SKF Gleitlager in Püttlingen, Germany. Provider was Peter Spengler at SKF Gleitlager. For most of the data it is not specified if the data is derived, monitored, estimated, from economical information or calculated in some other way. When some of these methods have been used, there will be a note about that in specific QMetaData. The data was recieved as annual inputs and outputs. Three different types of the plain bearing GE30 is manufactured at SKF Gleitlager. The inner diameter of all types are 30 mm. However the width of the outer ring differs between 18-22 mm and the inner ring between 22-30 mm. The mass of all types of the plain bearing GE30 is 0,16 kg per piece, except for a small amount of bearings that are of mass 0,17 kg per piece. This small amount effects the total very little and all plain bearings are therefor assumed to be of mass 0,16 kg per piece.
Notes	

SPINE LCI dataset: Manufacturing PU elastics

Administrative	
Finished	Y
Date Completed	1993-08-25
Copyright	None
Availability	Only CPM companies

Technical System	
Name	Manufacturing PU elastics
Functional Unit	1 kg PU
Functional Unit Explanation	
Process Type	Unit operation
Site	
Sector	Materials and components
Owner	
Technical system description	Theoretical model for manufacturing of polyurethane. MDI and PTMG are forming a prepolymere and solving in a solvent dimethyleacetamide (DMAC) and cured with 4,4'-diphenylmethanediamine (DMDA). n(HO(R1)OH) + n(OCN(R2)NCO) = H(O(R1)OCONH(R2)NHCO)nOH R1=(CH2)4O R2=C6H4CH2C6H4 MDI can be substituted by TDI, but this substance is more toxic. Other chain extenders than DMDA could be used, but this one is assumed to be close enough for this model.

System Boundaries	
Nature Boundary	No flows from and to nature
Time Boundary	No timeboundary since it is a theoretical model
Geographical Boundary	No geographical boundary since it is a theoretical model
Other Boundaries	Only consumption of materials as regards mass balance are included.
Allocations	No allocations
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	SKF Gleitlager in Püttlingen, Germany
Method	A supplier recipe stated the amounts of MDI and PTMG. Out of this the amounts it is possible to calculate the amounts of MDI and PTMG parts in the PU-prepolymer. 250g/mole is assumed for MDI, which makes 0.79 moles of MDI used in the reaction. There are two NCO-groups per MDI that could react to this, which gives 1,58 moles of NCO-groups. At the same time the PTMG has two OH-groups that could react, and each of them could react with MDI, which means that four NCO-groups will be involved in the reaction to PTMG in the prepolymer synthesis which finally gives a need of 0,39 moles of PTMG. With the recipe in mind , it looks like good assumption that the PTMG is of the type 2 000g/mole. In the curing process we have to take into account the small portions of diamines mentioned in the recipe. The recipe shows that the prepolymer will have 0,74 moles NCO-groups free for reaction with the curing substance. If each curing substance could react with one NCO-end of two prepolymers we should get 0.37 moles curing substance, or compared to the recipe a moleweight approx. 162 g/mole.

Literature Reference	SKF Gleitlager internal information as recived from Peter Spengler at SKF Gleitlager in Püttlingen, Germany.
Notes	The data are partly from 1996 and partly from 1998.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	DMAC	10			g	Technosphere	
	Input	Refined resource	DMDA	40			g	Technosphere	
	Input	Refined resource	MDI	185			g	Technosphere	
	Input	Refined resource	PTMG	755			g	Technosphere	
	Output	Product	PU	1			kg	Technosphere	

About Inventory

Publication	Internal report at SCA Mölnlycke: ''LCA model for Elastanes (segmented polyurethanes)'', G. Brohammer -- Data documented by: Ellen Riise, Mölnlycke AB Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	An attempt to map components and energy consumption of PU material
Detailed Purpose	
Commissioner	
Practitioner	Brohammer, Göran - KM Miljöteknik AB, Rullagergatan 6, 415 26 Göteborg.
Reviewer	Chihani, Thami - SCA Research, 405 03 Göteborg
Applicability	CERTAIN CAUTIONS: The dataset is an estimate and should be used with care.
About Data	GENERAL DATA SOURCE DESCRIPTION: The dataset is a purely theoretical model.
Notes	

SPINE LCI dataset: MDI - PUR precursors

Administrative

Finished	Y
Date Completed	1996
Copyright	
Availability	

Technical System

Name	MDI - PUR precursors
Functional Unit	1 kg MDI
Functional Unit Explanation	
Process Type	Cradle to gate
Site	
Sector	Materials and components

Owner	
Technical system description	This set of data concerns the production of the polyurethane precursors (TDI, MDI, Polyols) and not the production of the polyurethane foam. The principal raw materials for polyurethane precursors are crude oil and natural gas. The diisocyantes having the greatest commercial importance originate from the aromatic content (benzene and toluene), while the polyols come almost exclusively from the aliphatic content. Diisocyanates are obtained by phosphogenation of daimines which are produced, via a number of intermediates steps, from aromatic hydrocarbons. The diisocyanate with the greatest technical importance are tolyene diisocyanante (TDI) and diphenylmethane diisocyanate (MDI). The polyols used in polyurethane production are predominantly hydroxy-polyesters. They are produced by alkoxylation. Depending on the degree of cross-linking required, the starting alcohols used for hydroxy-polyethers may be divalent glycols (ethylene, propylene and other glycols) or multivalent alcohols. The epoxides used are generally propylene oxide and ethylene oxide.

System Boundaries

Nature Boundary	Air- , water- emission and waste out of our system Resource, input to our system
Time Boundary	
Geographical Boundary	Europe
Other Boundaries	
Allocations	Unspecified
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	98/01/26
Data Type	Unspecified
Represents	SKF Gleitlager in Püttlingen, Germany
Method	Normal LCI method for the production of MIDI (PUR precursors) - cradle to the gate
Literature Reference	Eco profiles ot the European plastics industry Report 9 : Polyurethane precursors (TDI, MDI, Polyols) APME technical report June 1996
Notes	The data are partly from 1996 and partly from 1998.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Bauxite	150			mg	Technosphere	Europe
	Input	Refined resource	Coal	0			MJ	Technosphere	Europe
	Input	Refined resource	Electricity	20			MJ	Technosphere	Europe
	Input	Refined resource	Heavy oil	27			MJ	Technosphere	Europe
	Input	Refined resource	Iron ore	690			mg	Technosphere	Europe
	Input	Refined resource	Limestone	9600			mg	Technosphere	Europe
	Input	Refined resource	NaCl	376000			mg	Technosphere	Europe
	Input	Refined resource	Natural sand	150			mg	Technosphere	Europe
	Input	Refined resource	Other fuel	58			MJ	Technosphere	Europe
	Input	Refined resource	SO2	77400			mg	Technosphere	Europe
	Input	Refined resource	Water	211000000			mg	Technosphere	Europe
	Output	Emission	BOD	500			mg	Water	Europe
	Output	Emission	Cl2	1			mg	Air	Europe
	Output	Emission	CO	3000			mg	Air	Europe
	Output	Emission	CO2	5230000			mg	Air	Europe
	Output	Emission	COD	2100			mg	Water	Europe
	Output	Emission	H2	600			mg	Air	Europe
	Output	Emission	H2S	3			mg	Air	Europe
	Output	Emission	H2SO4	150			mg	Water	Europe
	Output	Emission	HC	22300			mg	Water	Europe
	Output	Emission	HC	22300			mg	Air	Europe

	Output	Emission	HCl	280			mg	Air	Europe
	Output	Emission	HF	10			mg	Air	Europe
	Output	Emission	Metals	25			mg	Air	Europe
	Output	Emission	Metals	300			mg	Water	Europe
	Output	Emission	NOx	22900			mg	Air	Europe
	Output	Emission	Oil	60			mg	Water	Europe
	Output	Emission	Organic compounds	470			mg	Water	Europe
	Output	Emission	Particles	150			mg	Air	Europe
	Output	Emission	Phenol	10			mg	Water	Europe
	Output	Emission	SOx	35000			mg	Air	Europe
	Output	Emission	Sulphates	10200			mg	Water	Europe
	Output	Emission	Susp solids	1300			mg	Water	Europe
	Output	Product	MDI	1			kg	Technosphere	Europe
	Output	Residue	Ashes	36000			mg	Technosphere	Europe
	Output	Residue	Industrial waste	8000			mg	Technosphere	Europe
	Output	Residue	Mineral waste	132000			mg	Technosphere	Europe

About Inventory

Publication	Eco profiles ot the European plastics industry Report 9 : Polyurethane precursors (TDI, MDI, Polyols) APME technical report June 1996 --- Data documented by: Sophie Louis, Volvo Technical Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	APME's eco-profiles serve two
General Purpose	There is an increasing demand concerning LCA data. Following this trend, ISOPA [The European Isocyanate Producers Association] members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of MIDI (one of the precursors of PUR)
Commissioner	- ISOPA, Avenue E. van Nieuwenhuyse 4 Box 2 B 1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	It is important to recognise that the data do not refer only to the final conversion stages leading to the MDI but to all operations starting with raw materials in the Earth.
About Data	The transport of the different precursors to the plant where is produced polyurethane foam is not included here in this set of data. Data have been obtained from plants producing a total of 366000 tonnes of MDI monomer and polymer in 1990. The difference in the results for the monomeric and polymeric forms are insignificant and so a single average data has been produced. Data on the production processes have been supplied by ARCO Chemical, BASF, BAYER, DOW, Enichem, ICI, Rhone Poulenc and Shell relating to plants operating in Belgium, France Germany, Italy, the Netherlands, Portugal, Spain and the United Kingdom.
Notes	

SPINE LCI dataset: Medium speed, four-stroke diesel vessel engine

Administrative

Finished	Y
Date Completed	1991-01-01
Copyright	Swedish Transport Research Board

Availability	Public

Technical System

Name	Medium speed, four-stroke diesel vessel engine
Functional Unit	1 kWh, 80 % engine load
Functional Unit Explanation	1 kWh mechanical work done by the engine at 80 % engine load
Process Type	Unit operation
Site	Sweden
Sector	Machinery and equipment
Owner	Sweden
Technical system description	Operation of a medium speed, four-stroke diesel engine used in vessels.

System Boundaries

Nature Boundary	Regulated emissions to air are considered.
Time Boundary	The aim was that the data should represent engines in use in 1987.
Geographical Boundary	Engines used in Swedish vessels
Other Boundaries	The engine load i.e the power outtake is 80 %.
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1990-01-01
Data Type	Derived, unspecified
Represents	SKF Gleitlager in Püttlingen, Germany
Method	The emissions at 80 % engine load are based on measurement onboard three sailing vessels performed by IVL (Swedish Environmental Research Institute), material from engine manufacturers (Wärtsilää Diesel, MaK, MAN -B&W) and other projects that has conducted measurements onboard sailing vessels. The material from the engine manufacturers is based on tests performed on the engine installed in a test bench. The data can be found in Alexandersson. The oil consumption is based on assumptions (Alexandersson).
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18
Notes	The data are partly from 1996 and partly from 1998.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Heavy oil	200			g	Technosphere	
	Output	Emission	CO	1			g	Air	
	Output	Emission	CO2	620			g	Air	
	Output	Emission	HC	0.2			g	Air	
Method: Notes: The mean value of measurements onboard sailing vessels was 14,5 g/kWh. The results from the measurements varied between 9 and 19,4 g/kWh The mean value from the engine manufacturers was 13,7 g/kWh. The data varied between 7,5 and 15,5 g/kWh	Output	Emission	NOx	14			g	Air	
Notes: Data from engine manufacturers varied between 0,01 and 0,5 g/kWh.	Output	Emission	Particles	0.4			g	Air	
Method:	Output	Product	Mechanical work	1			kWh	Technosphere	

About Inventory	
Publication	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	
General Purpose	
Detailed Purpose	The data was compiled to obtain a basis to calculate the energy use and emissions of average engines installed in Swedish vessels.
Commissioner	- Swedish Transport Research Board, Swedish Maritime Administration, Swedish Shipowner Association, Swedish Environmental Protection Agency, Swedish Port Association and Board for Technical Development.
Practitioner	Alexandersson, Anders - MariTerm Göteborg.
Reviewer	
Applicability	The data was compiled to represent the energy use and emissions of average engines installed in Swedish vessels. The energy use and emissions for different engines may however vary. The data should therefore not be used as a basis to calculate the energy use and emissions of engines installed in international vessels. The emissions of particles and NOx are influenced by the fuel quality, depending on the nitrogen and sulphur content in the fuel. The development of engines has aimed to increase the efficiency of the engine, i.e. decrease the bunker consumption preserving the power outtake. This has resulted in an increase of the specific emissions of NOx, while the emissions of other parameters has decreased. The specific fuel consumption for fuel optimised four-stroke engines at normal operation at sea is 160 g/kWh. Older engines has a higher fuel consumption. The fuel quality has a large influence on the emissions of particles and NOx, depending on the nitrogen and sulphur content in the fuel. The development of engines has aimed to increase the efficiency of the engine, i.e. decrease the bunker consumption preserving the power outtake. This has resulted in an increase of the specific emissions of NOx, while the other emissions has decreased. The specific fuel consumption for fuel optimised four-stroke engines at normal operation at sea is 170-180 g/kWh. Older engines has a higher fuel consumption.
About Data	The data is based on measurements onboard sailing vessels and data from engine manufacturers.
Notes	The data was used as a basis to calculate the energy use and emissions for different vessels in the work of NGM published in Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997, NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997

SPINE LCI dataset: Medium speed, four-stroke diesel vessel engine

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	Swedish Transport Research Board
Availability	Public

Technical System	
Name	Medium speed, four-stroke diesel vessel engine
Functional Unit	1 kWh, 20 % engine load

Functional Unit Explanation	1 kWh mechanical work done by the engine at 20 % engine load
Process Type	Unit operation
Site	Sweden
Sector	Machinery and equipment
Owner	Sweden
Technical system description	Operation of a medium speed, four-stroke diesel engine used in vessels.

System Boundaries

Nature Boundary	Regulated emissions to air are considered.
Time Boundary	The aim was that the data should represent engines in use in 1987.
Geographical Boundary	Engines used in Swedish vessels
Other Boundaries	The engine load i.e the power outtake is 20 %.
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1989-01-01 - 1990-10-01
Data Type	Derived, unspecified
Represents	SKF Gleitlager in Püttlingen, Germany
Method	The emissions at 20 % engine load are based on measurement onboard three sailing vessels performed by IVL (Swedish Environmental Research Institute), material from engine manufacturers (Wärtsilää Diesel, MaK, MAN -B&W) and other projects that has conducted measurements onboard sailing vessels. The material from the engine manufacturers is based on tests performed on the engine installed in a test bench. The data can be found in Alexandersson. The oil consumption is based on assumptions (Alexandersson).
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18
Notes	The data are partly from 1996 and partly from 1998.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Oil	200			g	Technosphere	
	Output	Emission	CO	2.2			g	Air	
	Output	Emission	CO2	1120			g	Air	
	Output	Emission	HC	0.4			g	Air	
Notes: The mean value of measurements onboard sailing vessels was 14,5 g/kWh. The results from measurements varied between 9 and 19,4 g/kWh The mean value from the engine manufacturers was 13,7 g/kWh. The data varied between 7,5 and 15,5 g/kWh	Output	Emission	NOx	21			g	Air	
Notes: Data from engine manufacturers varied between 0,01 and 1.0 g/kWh.	Output	Emission	Particles	0.6			g	Air	
	Output	Product	Mechanical work	1			kWh	Technosphere	

About Inventory

Publication	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 --- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	

General Purpose	
Detailed Purpose	The data was compiled to obtain a basis to calculate the energy use and emissions of average engines installed in Swedish vessels.
Commissioner	- Swedish Transport Research Board, Swedish Maritime Administration, Swedish Shipowner Association, Swedish Environmental Protection Agency, Swedish Port Association and Board for Technical Development.
Practitioner	Alexandersson, Anders - MariTerm Göteborg.
Reviewer	
Applicability	The data was compiled to represent the energy use and emissions of average engines installed in Swedish vessels. The energy use and emissions for different engines may however vary. The data should therefore not be used as a basis to calculate the energy use and emissions of engines installed in international vessels. The emissions of particles and NOx are influenced by the fuel quality, depending on the nitrogen and sulphur content in the fuel. The development of engines has aimed to increase the efficiency of the engine, i.e. decrease the bunker consumption preserving the power outtake. This has resulted in an increase of the specific emissions of NOx, while the emissions of other parameters has decreased. The specific fuel consumption for fuel optimised four-stroke engines at normal operation at sea is 160 g/kWh. Older engines has a higher fuel consumption.
About Data	The data is based on measurements onboard sailing vessels and data from engine manufacturers.
Notes	The data was used as a basis to calculate the energy use and emissions for different vessels in the work of NGM published in Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997, NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997

SPINE LCI dataset: Medium weight truck, regional, Euro 0

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Medium weight truck, regional, Euro 0
Functional Unit	1 tonkm, 50 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 %. An utilisation level of 50 % is considered to be representative for Swedish domestic distribution traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of medium weight truck for regional traffic, approximately 10 m long with a curb weight of 24 tons and a maximum load of 14 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 4 l/10 km, medium 3.5 l/10 km, low 3 l/10 km. Engine type: Euro 0 (1990-1992). Utilisation level: 50% by weight.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1987 - 1992
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. Empty trips are not included. *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO_2 and SO_2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden

	Input	Refined resource	Diesel [Swe Mk1]	0.49	0.42	0.56	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.19	0.16	0.21	g	Air	Sweden
	Output	Emission	CO2	130	111	149	g	Air	Sweden
	Output	Emission	HC	0.11	0.090	0.12	g	Air	Sweden
	Output	Emission	NOx	2.2	1.9	2.5	g	Air	Sweden
	Output	Emission	Particles	0.050	0.043	0.057	g	Air	Sweden
	Output	Emission	SO2	1.6E-04	1.4E-04	1.9E-04	g	Air	Sweden

About Inventory	
Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the

Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle.

Handling of goods

The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials)
Terminal based road transports generally consists of 1-3 parts:
1. Collection of the goods to terminal
2. Long-distance transport between terminals
3. Distribution of the goods from terminal
The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation.

--*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport.
--*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited
--*Parcel goods (<100 kg)* are normally handled in small vehicles

The following vehicles and equipages are used in terminal based transport systems in Sweden:
--*Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels.
--*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic.
--*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic.
--*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--*Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic.

Utilisation level

The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

Bulky goods

The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel

The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure.

International road transports

The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.

About Data

The emission data of medium-sized and light trucks have been collected from certification values of new engines, driven according to fix driving cycles, e.g. ECR-49 (IVL and Mercedes).

Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Medium weight truck, regional, Euro 1

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Medium weight truck, regional, Euro 1
Functional Unit	1 tonkm, 50 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 %. An utilisation level of 50 % is considered to be representative for Swedish domestic distribution traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of medium weight truck for regional traffic, approximately 10 m long with a curb weight of 24 tons and a maximum load of 14 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 4 l/10 km, medium 3.5 l/10 km, low 3 l/10 km. Engine type: Euro 1 (1993-1995). Utilisation level: 50% by weight.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1991 - 1995
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. Empty trips are not included. *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.49	0.42	0.56	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.17	0.15	0.19	g	Air	Sweden
	Output	Emission	CO2	130	111	149	g	Air	Sweden
	Output	Emission	HC	0.090	0.077	0.10	g	Air	Sweden
	Output	Emission	NOx	1.4	1.2	1.5	g	Air	Sweden
	Output	Emission	Particles	0.025	0.021	0.029	g	Air	Sweden
	Output	Emission	SO2	1.6E-04	1.4E-04	1.9E-04	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket,

	Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used in terminal based transport systems in Sweden:*** --*Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for

	Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The emission data of medium-sized and light trucks have been collected from certification values of new engines, driven according to fix driving cycles, e.g. ECR-49 (IVL and Mercedes).
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Medium weight truck, regional, Euro 2

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Medium weight truck, regional, Euro 2
Functional Unit	1 tonkm, 50 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 %. An utilisation level of 50 % is considered to be representative for Swedish domestic distribution traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of medium weight truck for regional traffic, approximately 10 m long with a curb weight of 24 tons and a maximum load of 14 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 4 l/10 km, medium 3.5 l/10 km, low 3 l/10 km. Engine type: Euro 2 (1996-). Utilisation level: 50% by weight.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced 1993 - 1999
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. Empty trips are not included. *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel

	consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.49	0.42	0.56	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.13	0.11	0.14	g	Air	Sweden
	Output	Emission	CO2	130	111	149	g	Air	Sweden
	Output	Emission	HC	0.065	0.056	0.074	g	Air	Sweden
	Output	Emission	NOx	1.2	1.0	1.3	g	Air	Sweden
	Output	Emission	Particles	0.018	0.015	0.020	g	Air	Sweden
	Output	Emission	SO2	1.6E-04	1.4E-04	1.9E-04	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.

Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used. The age categories of the vehicles compiled in the work are: Older than 1990, Euro 0: Introduced 1987, law from 1990 Euro 1: Introduced 1991, law from 1993 Euro 2: Introduced 1993, law from 1996 However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle. ***Handling of goods*** The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials) Terminal based road transports generally consists of 1-3 parts: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation. *--Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. *--General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited *--Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used in terminal based transport systems in Sweden:*** *--Parcel truck/van, max 3,5 tonnes* is mainly used for transportation of parcels. *--Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. *--Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. *--Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. *--Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. *--Truck with semi-trailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %.

	Bulky goods The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The emission data of medium-sized and light trucks have been collected from certification values of new engines, driven according to fix driving cycles, e.g. ECR-49 (IVL and Mercedes).
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Medium weight truck, regional, made before 1990

Administrative	
Finished	Y
Date Completed	1998 - 08
Copyright	NTM
Availability	Public

Technical System	
Name	Medium weight truck, regional, made before 1990
Functional Unit	1 tonkm, 50 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 %. An utilisation level of 50 % is considered to be representative for Swedish domestic distribution traffic if *empty trips are not included.*
Process Type	Gate to gate
Site	Sweden
Sector	Land transport
Owner	Sweden

Technical system description	Operation of medium weight truck for regional traffic, approximately 10 m long with a curb weight of 24 tons and a maximum load of 14 tons. Fuel: diesel, MK 1 (sulphurous content: 2 ppm). Fuel consumption: high 4 l/10 km, medium 3.5 l/10 km, low 3 l/10 km. Engine type: made before 1990. Utilisation level: 50% by weight.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	Data are valid for trucks produced before 1990
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic. Empty trips are not included. *Parameters not considered* -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1998 - 08
Data Type	Derived, unspecified
Represents	NTM
Method	Data have been put together for NTM by a group of manufacturers and hauliers, i.e. Volvo, Scania, BTL, ASG, Swedish Hauliers Assosiation. Data are presented in relation to the transport work, in g/tonkm. The utilisation level is assumed to be 50% for delivery vans and medium-sized lorries in local distribution traffic and 70 % for long distance transport with heavy trucks. The utilisation level is based on the load carrying weight, i.e. the weight on which the customer price is based. This means that bulky cargo is multiplied with a factor in order to compensate for taking up volume. The average break-point density is 275 kg/m3. Energy use and emissions per tonkm with a truck should be based on the load carrying weight. The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the fuel consumption due to degeneration, driving behavour etc.. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, The emission data have been produced through simulations conducted by Volvo Trucks and Scania in 1997. The simulations were based on certification values for engines and fuel consumption under actual operation for Swedish conditions. For medium and light lorries, the emission values have been obtained from certification values for new engines that are operated in accordance with established operating cycles, e.g. ECR-49 (IVL and Mercedes). Emissions data related to fuel consumption Emission factors (g/liter) Euro 0 Euro 1 Euro 2 Law from: 1980 1990 1993 1996 NOx 52+/- 5 44 27 23 HC 6+/- 2 2.1 1.8 1.3 PM 3+/- 2 1 0.5 0.35 CO 8+/- 3 3.7 3.4 2.5 This shows emissions factors in g/l for heavy lorries. With fuel consumption as a basis, it is possible to calculate the emissions. The data on emissions are based on measurements in accordance with applicable standards for certification. liters/100 km Empty Full load Distribution lorry (Payload 8.5 ton) 20-25 25-30 Med.-size lorry (Payload 14 ton) 25-30 30-40 Heavy lorry w trailer (Payl. 26 ton) 22-27 32-38 Heavy lorry w 2 trail. (Payl. 40 ton) 28-33 43-55*
Literature Reference	

Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Diesel [Swe Mk1]	0.49	0.42	0.56	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.40	0.34	0.46	g	Air	Sweden
	Output	Emission	CO2	130	111	149	g	Air	Sweden
	Output	Emission	HC	0.30	0.26	0.34	g	Air	Sweden
	Output	Emission	NOx	2.6	2.2	3.0	g	Air	Sweden
	Output	Emission	Particles	0.15	0.13	0.17	g	Air	Sweden
	Output	Emission	SO2	1.6E-04	1.4E-04	1.9E-04	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	- Swedish haulages and transport companies .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for any detailed study of transport systems. More detailed information is needed in order to carry out such studies, e.g. regarding the vehicle -type -age and performance, fuel type, the nature of the goods, the utilisation level etc. For a specific transport, the company carrying out the transport should be contacted in order to get information on how the goods are handled and how the transport is carried out. Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over a longer period of time (e.g. a year) is needed, e.g. in a transport contract. In such a case, different types of vehicles and utilisation levels may have occurred. The standard values presented in this activity should not be used if specific information on

the fuel consumption for the transport is availiable. In this case, the fuel consumption should instead be used as a basis to calculate the emissions from the transport. See General QMetaData for emission factors that can be used to calculate emissions per litre fuel used.

The age categories of the vehicles compiled in the work are:
Older than 1990,
Euro 0: Introduced 1987, law from 1990
Euro 1: Introduced 1991, law from 1993
Euro 2: Introduced 1993, law from 1996
However, in order to improve the accuracy of the calculations, the user ought to know the Euro-class (emission standards) of the vehicle, rather than to base the calculations on the age of the vehicle.

Handling of goods
The data presented by NTM is representative for a terminal based transport system. The vehicles can be used in different ways, primarily altering the degree of utilisation. Several other types of road based cargo transport systems is not well described by the data (e.g. oil and excavated materials)
Terminal based road transports generally consists of 1-3 parts:
1. Collection of the goods to terminal
2. Long-distance transport between terminals
3. Distribution of the goods from terminal
The collection and distribution routes are generally performed by smaller vehicles while the inter-terminal traffic is operated by larger units, typically with a higher degree of utilisation.

--Wholesale goods (>1000 kg) are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport.
--General goods (100-1000 kg) are generally handled via terminal. The goods may be both weight and volume limited
--Parcel goods (<100 kg) are normally handled in small vehicles

The following vehicles and equipages are used in terminal based transport systems in Sweden:
--Parcel truck/van, max 3,5 tonnes is mainly used for transportation of parcels.
--Light truck, max 8 tonnes is used for local distribution, mainly in city traffic.
--Truck, max 18 tonnes is used for district distribution and local distribution in city traffic.
--Truck, max 24 tonnes is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--Heavy truck with trailer, max 60 tonnes is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--Truck with semi-trailer, max 42 tonnes is used for international long-distance traffic.

Utilisation level
The data is only applicable for an utilisation level of 70 % for long distance transport and 50 % for local distribution and regional transport, which is considered representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip, due to specialised vehicles). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than smaller firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1, except for petrol driven delivery vans who are assumed to use standard unleaded petrol. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (> 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbonhydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the data. NGM propose that data from Blinge et. al (Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997) should be used. This study is based

	on best available technology and Swedish conditions which is likely to yield a low figure. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. This will alter both the SOx emission and the regulated engine emissions. Generally the fleets in western Europe is composed of newer vehicles than in Sweden. The utilisation of the vehicles may also vary in different countries.
About Data	The emission data of medium-sized and light trucks have been collected from certification values of new engines, driven according to fix driving cycles, e.g. ECR-49 (IVL and Mercedes).
Notes	The person stated as ''Practitioner'' is the contact person for the data for truck transportation in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: Metal coating of cold reduced steel sheets

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Metal coating of cold reduced steel sheets
Functional Unit	1 kg zinc coated steel sheet.
Functional Unit Explanation	
Process Type	Unit operation
Site	SSAB Tunnplåt
Sector	
Owner	SSAB Tunnplåt
Technical system description	This activity describes a process step included in the system ''Production of plywood boxes'', also available in the SPINE@CPM database. Plywood boxes are used to pack the coated and non-coated roller bearings from SKF, Göteborg, during the transportation to customers. The plywood boxes are manufactured by Nefab Emballage AB in Alfta, Sweden. The plywood box consist of plywood, steel strips, steel nails and wooden splits. The steel for the steel strips is hot rolled, pickled, cold reduced and finally coated at SSAB Tunnplåt`s line in Borlänge. This dataset describes the metal coating of 1 kg cold reduced steel sheet at SSAB Tunnplåt AB in Borlänge.  This environmental profile refers to the mean values of emissions caused by metal coating at SSAB Tunnplåt`s line in Borlänge during the years 1997-1998. All data for the process is obtained from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000.

	The data refers to an existing EPD from SSAB Tunnplåt AB: Environmental Product Declaration from SSAB; SE 520; August 1998.

System Boundaries

Nature Boundary	Emissions to air and water are included. The steel scrap from the process is reused as raw material and is thus not considered as waste, but as a co-product ending in the technosphere. For more detailed information see the EPD SE 520 from SSAB Tunnplåt AB.
Time Boundary	This environmental profile refers to the mean values of emissions caused by metal coating at SSAB Tunnplåt`s line in Borlänge during the years 1997-1998.
Geographical Boundary	The process takes place at SSAB Tunnplåt`s line in Borlänge, Sweden.
Other Boundaries	The production of electricity is NOT included in the dataset, but must be followed from the cradle in order to obtain the total environmental impact. This must also be done with the production of LPG. For more detailed information see the EPD SE 520 from SSAB Tunnplåt AB.
Allocations	Allocations have been made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	NTM
Method	The data is taken from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000.
Literature Reference	[1] Source: EPD (SE 520, 1998) from SSAB for the product Dogal.
Notes	Calculating the environmental impact in relation to transport work and utilisation level is most appropriate if a calculation over the year is needed, e.g. in a transport deal, which often covers a year's time. In such a case, different types of vehicles and utilisation levels may have occurred.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: (1)	Input	Refined resource	Al	0.170			g	Ground	
	Input	Refined resource	Cold reduced steel sheet	0.99			kg	Technosphere	
Notes: The energy carrier was called Electricity, Swedish average in LCAiT 3.	Input	Refined resource	Electricity	0.540			MJ	Technosphere	
	Input	Refined resource	Liquefied petroleum gas	0.252			MJ	Technosphere	
Notes: (1)	Input	Refined resource	Zn	56.750			g	Ground	
	Output	Co-product	Steel scrap	17			g	Technosphere	Sweden
	Output	Emission	CO2	15			g	Air	
	Output	Emission	NOx	2.00e-002			g	Air	
	Output	Emission	Oil	2.00e-004			g	Water	
	Output	Emission	P total	3.00e-005			g	Water	
	Output	Emission	Particles	3.00e-004			g	Water	
	Output	Product	Zinc coated steel sheet	1			kg	Technosphere	
	Output	Residue	Solid	0.100			g	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ------------ Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics,

	Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. Both types of bearings are packed in a plywood box. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for metalcoating of 1 kg cold-reduced steel sheet at SSAB Tunnplåt`s line in Borlänge, Sweden.
About Data	All data for the process is obtained from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. The data refers to an existing EPD from SSAB Tunnplåt AB: Environmental Product Declaration from SSAB; SE 520; August 1998.
Notes	

SPINE LCI dataset: Metal surface treatment of car- and boat details

Administrative	
Finished	Y
Date Completed	1996-03-01
Copyright	
Availability	Public

Technical System	
Name	Metal surface treatment of car- and boat details
Functional Unit	1995
Functional Unit Explanation	The data is stated for the total production during 1995. The company are not obligated to state their extent of production, why it is impossible to relate the environmental load to a functional unit.
Process Type	Gate to gate
Site	Dryselius, ChristerPollux Ytbehandling AB
Sector	Materials and components
Owner	Dryselius, ChristerPollux Ytbehandling AB
Technical system description	Electropolishing and anodizing.

System Boundaries	
Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden

Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1995-03-03
Data Type	
Represents	NTM
Method	Study the environmental report and talk to Christer Dryselius at Pollux Ytbehandling AB.
Literature Reference	Environmental report concerning 1995, Pollux Ytbehandling AB, The Environmental Administration in the municipality of Göteborg, Sweden
Notes	Method to determine the consumption of sulphur, phosphorus, lye, nitric acid and triclorethylene can be found under Specific QMetaData for Sulphur.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Lye	11.5			tonne	Technosphere	Sweden
	Input	Refined resource	Nitric acid	1			tonne	Technosphere	Sweden
	Input	Refined resource	Phosphorus	5			tonne	Technosphere	Sweden
Date concieved: 1995-03-01 Data type: Economical information Method: The data for raw materials is taken from the company's purchase receipts. Literature: Personal communication: Christer Dryselius, Pollux Ytbehandling AB.	Input	Refined resource	Sulphur	5			tonne	Technosphere	Sweden
	Input	Refined resource	Trichlorethylene	0.9			tonne	Technosphere	Sweden
Date concieved: 1995-03-01 Data type: Single sample Method: Samples are taken continuos with a time-controlled instrument and collected in 24 hour-samples. Every 24 hour-sample is saved for a week, in case of an incident, and than it is refilled by another 24 hour-sample. The consulting company MJ's Water-Filter AB (see Literature reference) is engaged four times a year to collect the 24 hour-samples from the latest week and send it to the analyse company KM-Lab (see Literature reference) for analyse. The analyse methods are standardised, but not further specified. Literature: Environmental report concerning 1995 for Pollux Ytbehandling AB, The Environmental Administration in the municipality of Göteborg, Sweden Personal communication: Christer Dryselius, Pollux Ytbehandling AB Stig Johansson, MJ's Water-Filter AB in Göteborg, Sweden KM-Lab, Kasen 27 B, 451 50 Uddevalla, Sweden, Phone +46 522 140 90 Notes: KM-Lab is a laboratory that is accredited according to Swedish law.	Output	Emission	Cr	0.45			kg	Water	
Date concieved: 1995-03-01 Data type: Single sample Method: Samples are taken continuos with a time-controlled instrument and collected in 24 hour-samples. Every 24 hour-sample is saved for a week, in case of an	Output	Emission	Ni	0.42			kg	Water	

incident, and than it is refilled by another 24 hour-sample. The consulting company MJ's Water-Filter AB (see Literature reference) is engaged four times a year to collect the 24 hour-samples from the latest week and send it to the analyse company KM-Lab (see Literature reference) for analyse. The analyse methods are standardised, but not further specified. Literature: Environmental report concerning 1995 for Pollux Ytbehandling AB, The Environmental Administration in the municipality of Göteborg, Sweden Personal communication: Christer Dryselius, Pollux Ytbehandling AB Stig Johansson, MJ's Water-Filter AB in Göteborg, Sweden KM-Lab, Kasen 27 B, 451 50 Uddevalla, Sweden, Phone +46 522 140 90 Notes: KM-Lab is a laboratory that is accredited according to Swedish law.									
Date concieved: 1995-03-01 Data type: Economical information Method: The data for emissions to air is based on the company's purchase receipt. They estimate the whole amount of the substance to be let out to the air. Literature: Personal communication: Christer Dryselius, Pollux Ytbehandling AB	Output	Emission	Trichloroethylene	0.9			tonne	Air	
Date concieved: 1995-03-01 Data type: Economical information Method: The waste is weighted (in a mixture) when it is delivered to RECI Industry AB who takes care of the waste. Further, the company has estimated that the waste contains Cr (50%) and Ni (50%). Literature: Personal communication: Christer Dryselius, Pollux Ytbehandling AB	Output	Residue	Hazardous waste	11			tonne	Technosphere	

About Inventory

Publication	Environmental report concerning the activities 1995 at Pollux Ytbehandling AB, The Environmental Administration in the municipality of Göteborg, Sweden Personal communication: Christer Dryselius, Pollux Ytbehandling AB -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Dryselius, Christer - Pollux Ytbehandling AB.
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.

Applicability	The extent of the production is not mentioned in the Environmental report. Because of this we have no functional unit which makes it impossible to use the data direct for life cycle analysis. Though, it is possible to get in touch with the company and try to get some more information. The objects that undergoes the metal surface treatment is not mentioned nor calculated for as an input. The function of the technical system is not sufficently described. Contact the company to get the necessary details.
About Data	The torrent of waste water to the sewage treatment works is 4949 m3/år. The data is representing the emission etc during a year. Legislated limits for the plant: Torrent of water from the electropolishing 0,5 m3/h Maximum temperature (Celsius) 45 pH 6,5-10,0 Ni 1,0 mg/l Cr 1,0 mg/l
Notes	

SPINE LCI dataset: Mexico, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Mexico, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Mexico
Sector	Energyware
Owner	Mexico
Technical system description	The generation of electricity with different power generating systems in Mexico during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	NTM
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	101035			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	17828			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	23940			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	24616			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	5			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	5657			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	9265			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	182346			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow.

	When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Mining to sodium chloride APME

Administrative	
Finished	Y
Date Completed	1994
Copyright	APME
Availability	Public

Technical System	
Name	Mining to sodium chloride APME
Functional Unit	1 kg of sodium chloride, purified
Functional Unit Explanation	Sodium chloride (NaCl) purified to a quality that can be used in the electrolysis for chlorine.
Process Type	Cradle to gate

Site	European average values, Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average values, Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	Production of sodium chloride including all major operations from extraction of raw materials from the ground to purification. There are two different methods for extraction of sodium chloride from naturally occurring salt deposits: rock salt mining and brine pumping. Data have been collected for mining of 4,15E5 tonnes of rock salt and brine pumping of some 4,1E6 tonnes of sodium chloride (solid content). In brine pumping, water is pumped into a salt deposit to produce a saturated solution of sodium chloride, which can then be pumped to the surface. The main impurities present in the brine are magnesium, calcium and sulphate ions (total concentration is typically 0,6 wt%). Magnesium and calcium ions are removed by precipitation as insoluble magnesium hydroxide and calcium carbonate, respectively. Sulphate ions can be removed by precipitaion as barium sulphate or calcium sulphate. The impurities present in mined sodium chloride are similar to those in brine, but the concentrations are usually higher. The brine purification step adds significantly to the energy requirements for sodium chloride production. The extracted sodium chloride can be transported by pumping a saturated solution along a pipeline to a plant nearby. Alternatively, it can be purified and crystallized as a solid (containing approx. 3% moisture) for transport by road or rail. Rock salt is frequently transported ''as mined'', and purified at the destination. For the electricity taken in from the public supply, most likely, the calculations have taken account of the country specific electricity production efficiency. Some more information about the processes are found in the ''Eco-profiles...'' report 6, pp 9-12.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available.'' Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since parameters that are not monitored by the companies have been estimated.
Time Boundary	The year of data collection is not explicitly stated, but it is probably 1989 and/or 1990.
Geographical Boundary	Results are based on data obtained from raw material suppliers to PVC production plants in Europe. Possibly, most of the sodium chloride production sites are also in Europe. Data were averaged over all sodium chloride production sites examined and weighted by the total production (mass) from each site; i e not only the inputs to chlorine production were considered.
Other Boundaries	No excluded subsystems are mentioned. No cut-off criteria for exclusion of minor inputs and outputs are stated.
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1990
Data Type	Derived, mixed
Represents	NTM
Method	Results are based on data from raw material suppliers to PVC production plants in Europe. Data were averaged over all sodium chloride production sites and weighted by the total production (mass) from each site. For fuels and energy, the following gross calorific values (energy content) have been used in the calculations: 45,0 MJ/kg for oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal.
Literature Reference	''Eco-profiles of the European plastics industry'' Report 6: Polyvinyl chloride, I. Boustead, APME, 1994, data from Tables 10-11. (APME = Association of Plastics Manufacturers in Europe)
Notes	As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field, if the name has been changed significantly. 20000111 SECRC/GM

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Data type: Unspecified Notes: ''Coal'', gross primary fuel resource	Input	Natural resource	*Coal (energy resource)	0.366			MJ	Ground	
Data type: Unspecified Notes: ''Gas'' (natural gas), gross primary fuel resource	Input	Natural resource	*Gas (energy resource)	1.693			MJ	Ground	
Data type: Unspecified Notes: ''Hydro'', gross primary fuel	Input	Natural resource	*Hydro power	0.045			MJ	Ground	
Data type: Unspecified Literature: [1] ''Eco-profiles of the European plastics industry, Report 2: Olefin feedstock sources'', I. Boustead, APME/PWMI, 1993. [2] ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, APME, 1999, p52 (report available at http://lca.apme.org). [3] ''Okoinventare fur Energiesysteme'', R. Frischknecht & al, ETH, 1994. Notes: ''Nuclear'' power, 0,210 MJ, gross primary fuel. If 35% efficiency [1,2] and 7,96 mg uranium resource/MJ electricity [3] are assumed, 0,210 MJ Nuclear power corresponds to 0,210*0,35*7,96=0,585 mg of natural uranium (*U) resource. 20000111 SECRC/GM	Input	Natural resource	*Nuclear power	0.21			MJ	Ground	
Data type: Unspecified Notes: ''Oil'', gross primary fuel resource	Input	Natural resource	*Oil (energy resource)	0.699			MJ	Ground	
	Input	Natural resource	Limestone	14			g	Ground	
Data type: Unspecified Notes: ''Other'', unspecified gross primary fuel	Input	Natural resource	Other energy	0.024			MJ	Ground	
	Input	Natural resource	Sand	60			mg	Ground	
	Input	Natural resource	Sodium chloride	1.07			kg	Ground	
Data type: Unspecified Notes: ''Water'' raw material	Input	Natural resource	Water	4.6			kg	Ground	
Data type: Unspecified Notes: ''BOD'', biological oxygen demand	Output	Emission	BOD	1			mg	Water	
Data type: Unspecified Notes: ''Chloride ions''	Output	Emission	Chloride Cl-	34			g	Water	
Data type: Unspecified Notes: ''Carbon monoxide''	Output	Emission	CO Carbon monoxide	90			mg	Air	
Data type: Unspecified Notes: ''Carbon dioxide''	Output	Emission	CO2 Carbon dioxide	175			g	Air	
Data type: Unspecified Notes: ''COD'', chemical oxygen demand	Output	Emission	COD	4			mg	Water	
Data type: Unspecified Notes: ''Dissolved solids'', unspecified	Output	Emission	Dissolved solids TDS	30			mg	Water	
Data type: Unspecified Notes: ''Hydrocarbons'', unspecified	Output	Emission	HC Hydrocarbons	2			g	Air	
Data type: Unspecified Notes: ''Hydrogen chloride''	Output	Emission	HCl Hydrogen chloride	10			mg	Air	
Data type: Unspecified Notes: ''Metals'', unspecified	Output	Emission	Metal emission	7			mg	Water	
Data type: Unspecified Notes: ''Sodium ions''	Output	Emission	Na Sodium	90			mg	Water	
Data type: Unspecified Notes: ''Nitrogen oxides''	Output	Emission	NOx	1.5			g	Air	
Data type: Unspecified Notes: ''Dust''	Output	Emission	Particles	0.32			g	Air	
Data type: Unspecified Notes: ''Sulphur oxides''	Output	Emission	SO2 Sulphur dioxide	1.1			g	Air	
Data type: Unspecified Notes: ''Sulphate ions''	Output	Emission	Sulphate SO42-	7			g	Water	
Data type: Unspecified Notes: ''Suspended solids''	Output	Emission	Susp solids	1.3			g	Water	
Data type: Unspecified Notes: ''purified sodium chloride''	Output	Product	Sodium chloride	1			kg	Technosphere	

Data type: Unspecified Notes: ''Industrial waste'', other wastes, e g, discarded packagings and general household waste	Output	Residue	Industrial waste	0.2			g	Technosphere	
Data type: Unspecified Notes: ''Mineral waste'', waste earth and rock from mining operations	Output	Residue	Mineral waste	21			g	Technosphere	
Data type: Unspecified Notes: ''Inert chemicals'', can be sent to landfill sites without further treatment	Output	Residue	Non-toxic chemicals	12			g	Technosphere	
Data type: Unspecified Notes: ''Slags & ash'', usually inert solid waste produced by industrial boilers and furnaces	Output	Residue	Slags and ashes	1.7			g	Technosphere	

About Inventory

Publication	''Eco-profiles of the European plastics industry'' Report 6: Polyvinyl chloride, I. Boustead, APME, 1994, data from Tables 10-11. Report 2: Olefin feedstock sources, I. Boustead, APME, 1993. Updated reports are available at APME's web site http://lca.apme.org/reports (APME = Association of Plastics Manufacturers in Europe) The APME project co-ordinator: Vince Matthews. The members of the original independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom. -- Editor: Data entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 2000-01-11. Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Göteborg
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i e LCAs) of individual products. Note that the role of sodium chloride in the study is only as a raw material for production of chlorine, which is used in the production of PVC.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The data are calculated on a cradle to gate basis, therefore, no supplier activities should be connected to, e g, nuclear power, coal and limestone.
About Data	Data for sodium chloride production are included in the European average data for PVC production, which were issued by APME (Association of Plastics Manufacturers in Europe) and produced in association with the independent expert I. Boustead. The number of producers is not stated, only the volumes of produced sodium chloride (4,15E5 tonnes + 4,1E6 tonnes). Hence, whether the data are representative for production of sodium chloride in Europe is not known. However, the data quality is dependent on the quality of the records maintained by the individual companies. Site-specific data for raw materials and fuels have been used when available. Data from other manufacturers have been used in other cases. The quality of data for public electricity production is not described. For fuels and energy, the following gross calorific values (energy content) have been used in the calculations: 45,0 MJ/kg for oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal.
Notes	

SPINE LCI dataset: Mining to sodium hydroxide APME

Administrative	
Finished	Y
Date Completed	1994
Copyright	APME
Availability	Public

Technical System	
Name	Mining to sodium hydroxide APME
Functional Unit	1 kg of sodium hydroxide
Functional Unit Explanation	Sodium hydroxide (NaOH) produced by sodium chloride electrolysis and concentrated to about 50 wt%.
Process Type	Cradle to gate
Site	European average values, Used for identification of owner and/or site in Object of study under Technical system for activity
Sector	Materials and components
Owner	European average values, Used for identification of owner and/or site in Object of study under Technical system for activity
Technical system description	Production of sodium hydroxide including all major operations from extraction of raw materials (mainly sodium chloride) from the ground, to co-production of chlorine, sodium hydroxide and hydrogen by electrolysis, and concentration of the sodium hydroxide solution. There are two different methods for extraction of sodium chloride from naturally occurring salt deposits: rock salt mining and brine pumping. The data for mining/extraction and purification of sodium chloride are available in a separate data set. Sodium chloride electrolysis: 2 NaCl(aq) + H2O = 2 NaOH(aq) + Cl2(g) + H2(g) Three different electrolytic cells are used: the amalgam or mercury cell, the diaphragm cell and the membrane cell. In the mercury cell, the cathode consists of mercury flowing across the cell floor. Saturated sodium chloride solution flows above the cathode. At the anode, chloride ions are oxidised to chlorine gas, which is collected and taken from the cell. At the cathode, sodium ions are reduced to form sodium metal, which forms an amalgam with the mercury. The amalgam is removed from the cell and sent to a separate reactor where the sodium in the amalgam is reacted with water to form sodium hydroxide and hydrogen gas. In the diaphragm and membrane cells, the anode and cathode compartments are separated. The sodium chloride solution is contained within a diaphragm or a membrane. In this anode compartment, chlorine gas is evolved. At the cathode mesh outside the diaphragm/membrane, water is reduced to hydrogen gas, leaving a sodium hydroxide solution. Data have been obtained from 14 chlor-alkali plants producing some 2,4E6 tonnes of chlorine and 1,95E6 tonnes of sodium hydroxide. For the electricity taken in from the public supply, most likely, the calculations have taken account of the country specific electricity production efficiency. Some more information about the processes are found in the ''Eco-profiles...'' report 6, pp 9-15, and also in report 5.

System Boundaries	
Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available.'' Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since parameters that are not monitored by the companies have been estimated.
Time Boundary	The year of data collection is not explicitly stated, but it is probably 1989 and/or 1990.
Geographical Boundary	Results are based on data obtained from raw material suppliers to PVC production plants in Europe. Possibly, most of the chlor-alkali production sites are also in Europe. Data were averaged over all chlor-alkali production sites and weighted by the output from all of the producers.
Other Boundaries	No excluded subsystems are mentioned. No cut-off criteria for exclusion of minor inputs and outputs are stated.

Allocations	The inputs and outputs associated with the operation of the electrolysis plants have been partitioned between the different co-products chlorine, sodium hydroxide and hydrogen in the following way: 1) Sodium chloride raw material has been partitioned between chlorine and sodium hydroxide on the basis of the relative atomic masses of Na and Cl: 39,3% to sodium hydroxide, 60,7% to chlorine. 2) The thermal energy has been totally attributed to sodium hydroxide. 3) The electricity has been partitioned on a mass basis using the masses of the products sodium hydroxide, chlorine and hydrogen: 52,3% to sodium hydroxide, 46,4% to chlorine, 1,3% to hydrogen. 4) All emissions are treated as arising from all of the products of the plant and have, thus, been partitioned across all products on a mass basis: 52,3% to sodium hydroxide, 46,4% to chlorine, 1,3% to hydrogen. The allocation is discussed thoroughly in the ''Eco-profiles...'' report 5.
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1990
Data Type	Derived, mixed
Represents	NTM
Method	Results are based on data from raw material suppliers to PVC production plants in Europe. Data were averaged over all chlor-alkali production sites and weighted by the output from all of the producers. For fuels and energy, the following gross calorific values (energy content) have been used in the calculations: 45,0 MJ/kg for oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal.
Literature Reference	''Eco-profiles of the European plastics industry'' Report 6: Polyvinyl chloride, I. Boustead, APME, 1994, data from Tables 18-19. (APME = Association of Plastics Manufacturers in Europe)
Notes	As the APME substance nomenclature and the ABB database nomenclature sometimes differ, the original APME substance name is given within '''' in the flow metadata Notes field, if the name has been changed significantly. 20000114 SECRC/GM

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Data type: Unspecified Notes: ''Coal'', gross primary fuel resource	Input	Natural resource	*Coal (energy resource)	5.86			MJ	Ground	
Data type: Unspecified Notes: ''Gas'' (natural gas), gross primary fuel resource	Input	Natural resource	*Gas (energy resource)	4.76			MJ	Ground	
Data type: Unspecified Notes: ''Hydro'', gross primary fuel	Input	Natural resource	*Hydro power	0.71			MJ	Ground	
Data type: Unspecified Literature: [1] ''Eco-profiles of the European plastics industry, Report 2: Olefin feedstock sources'', I. Boustead, APME/PWMI, 1993. [2] ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, APME, 1999, p52 (report available at http://lca.apme.org). [3] ''Okoinventare fur Energiesysteme'', R. Frischknecht & al, ETH, 1994. Notes: ''Nuclear'' power, 5,74 MJ, gross primary fuel. If 35% efficiency [1,2] and 7,96 mg uranium resource/MJ electricity [3] are assumed, 5,74 MJ Nuclear power corresponds to 5,74*0,35*7,96=16,0 mg of natural uranium (*U) resource. 20000114 SECRC/GM	Input	Natural resource	*Nuclear power	5.74			MJ	Ground	
Data type: Unspecified Notes: ''Oil'', gross primary fuel resource	Input	Natural resource	*Oil (energy resource)	3.5			MJ	Ground	
	Input	Natural resource	Iron ore	0.46			g	Ground	
	Input	Natural resource	Limestone	10.5			g	Ground	
Data type: Unspecified Notes: ''Other'', unspecified gross primary fuel	Input	Natural resource	Other energy	0.17			MJ	Ground	

	Input	Natural resource	Sand	0.2			g	Ground	
	Input	Natural resource	Sodium chloride	0.59			kg	Ground	
Data type: Unspecified Notes: ''Water'' raw material	Input	Natural resource	Water	5.3			kg	Ground	
Data type: Unspecified Notes: ''Acid as H+''	Output	Emission	Acidification equivalent	0.27			g	Water	
Data type: Unspecified Notes: ''BOD'', biological oxygen demand	Output	Emission	BOD	3			mg	Water	
Data type: Unspecified Notes: ''Chloride ions''	Output	Emission	Chloride Cl-	29			g	Water	
Data type: Unspecified Notes: ''Carbon monoxide''	Output	Emission	CO Carbon monoxide	0.7			g	Air	
Data type: Unspecified Notes: ''Carbon dioxide''	Output	Emission	CO2 Carbon dioxide	1.12			kg	Air	
Data type: Unspecified Notes: ''COD'', chemical oxygen demand	Output	Emission	COD	13			mg	Water	
Data type: Unspecified Notes: ''Dissolved solids'', unspecified	Output	Emission	Dissolved solids TDS	50			mg	Water	
Data type: Unspecified Notes: ''Hydrocarbons'', unspecified	Output	Emission	HC Hydrocarbons	6.5			g	Air	
Data type: Unspecified Notes: ''Hydrogen chloride''	Output	Emission	HCl Hydrogen chloride	0.15			g	Air	
Data type: Unspecified Notes: ''Metals'', unspecified	Output	Emission	Metal emission	2			mg	Air	
Data type: Unspecified Notes: ''Metals'', unspecified	Output	Emission	Metal emission	70			mg	Water	
Data type: Unspecified Notes: ''Sodium ions''	Output	Emission	Na Sodium	4.1			g	Water	
Data type: Unspecified Notes: ''Nitrogen oxides''	Output	Emission	NOx	7.2			g	Air	
Data type: Unspecified Notes: ''Dust''	Output	Emission	Particles	3.1			g	Air	
Data type: Unspecified Notes: ''Sulphur oxides''	Output	Emission	SO2 Sulphur dioxide	10			g	Air	
Data type: Unspecified Notes: ''Sulphate ions''	Output	Emission	Sulphate SO42-	3.9			g	Water	
Data type: Unspecified Notes: ''Suspended solids''	Output	Emission	Susp solids	1.2			g	Water	
Data type: Unspecified Notes: ''Sodium hydroxide''	Output	Product	Sodium hydroxide	1			kg	Technosphere	
Data type: Unspecified Notes: ''Industrial waste'', other wastes, e g, discarded packagings and general household waste	Output	Residue	Industrial waste	1			g	Technosphere	
Data type: Unspecified Notes: ''Mineral waste'', waste earth and rock from mining operations	Output	Residue	Mineral waste	55			g	Technosphere	
Data type: Unspecified Notes: ''Inert chemicals'', can be sent to landfill sites without further treatment	Output	Residue	Non-toxic chemicals	7			g	Technosphere	
Data type: Unspecified Notes: ''Slags & ash'', usually inert solid waste produced by industrial boilers and furnaces	Output	Residue	Slags and ashes	11			g	Technosphere	
Data type: Unspecified Notes: ''Regulated chemicals'', chemical waste that has to be sent to special storage sites because it is either corrosive or toxic	Output	Residue	Toxic chemicals	20			mg	Technosphere	

About Inventory

Publication	''Eco-profiles of the European plastics industry'' Report 6: Polyvinyl chloride, I. Boustead, APME, 1994, data from Tables 10-11. Report 5: Co-product allocation in chlorine plants, I. Boustead, APME, 1994. Report 2: Olefin feedstock sources, I. Boustead, APME, 1993. Updated reports are available at APME's web site http://lca.apme.org/reports (APME = Association of Plastics Manufacturers in Europe) The APME project co-ordinator: Vince Matthews. The members of the original independent expert panel: Ian Boustead, Paul Fink, Horst Langowski, Gustav Sundstrom.

	-- Editor: Data entered into the SPINE format by Gunnar Mattsson, ABB Corporate Research, 2000-01-14. Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Göteborg
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	1) Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2) Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i e LCAs) of individual products. Note that the role of sodium hydroxide in the study is only as a by-product in the production of chlorine, which is used for production of PVC.
Commissioner	- APME, Association of Plastics Manufacturers in Europe Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels .
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	The data are calculated on a cradle to gate basis, therefore, no supplier activities should be connected to, e g, nuclear power, coal and limestone.
About Data	Data for sodium hydroxide production are included in the European average data for PVC production, which were issued by APME (Association of Plastics Manufacturers in Europe) and produced in association with the independent expert I. Boustead. The number of producers is probably 14, i.e. the same as for chlorine; the production volume was some 1,95E6 tonnes of sodium hydroxide. Hence, whether the data are representative for production of sodium hydroxide in Europe is not known. However, the data quality is dependent on the quality of the records maintained by the individual companies. Site-specific data for raw materials and fuels have been used when available. Data from other manufacturers have been used in other cases. The quality of data for public electricity production is not described. For fuels and energy, the following gross calorific values (energy content) have been used in the calculations: 45,0 MJ/kg for oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal.
Notes	

SPINE LCI dataset: Modified natural gas vehicle (NGV) operating on CNG with 15 % hydrogen (HCNG-15). ESA-DBP

Administrative	
Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Modified natural gas vehicle (NGV) operating on CNG with 15 % hydrogen (HCNG-15). ESA-DBP
Functional Unit	1 vehicle km
Functional Unit Explanation	Not applicable.
Process Type	Gate to gate
Site	Unknown

Sector	Land transport
Owner	Unknown
Technical system description	Ford F-150 pickup truck. Excerpts from the report (see 'Publication'): ''The test vehicle was operated on 100% CNG and blends of 15 and 30% HCNG. The test conditions and results are given in Karner and Francfort (2003b). Unlike the Dodge Ram Wagon Van, the Ford F-150 test vehicle is equipped with a factory CNG engine that is modified to run on blends of CNG and up to 30% hydrogen by volume. The modifications include supercharging, ignition modifications, and exhaust gas recirculation. The emission measurements were also performed according to the Federal Test Procedure (FTP-75).'' This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf Other processes in the CPM Database also included in the above publication: 'Extraction and processing of natural gas (NG). ESA-DBP' 'Unmodified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP' 'Unmodified natural gas vehicle (NGV) operating on CNG wiith 15 % hydrogen (HCNG-15). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on CNG wiith 30 % hydrogen (HCNG-30). ESA-DBP'

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	Data monitored in 2003.
Geographical Boundary	Test made in Arizona, USA.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2003
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	The emission measurements were performed according to the Federal Test Procedure (FTP-75). This test consists of three phases (cold start, transient and hot start), which cover 1,874 seconds and 17.77 kilometres at an average speed of 33.96 km/h.
Literature Reference	Karner, D. and J. E. Francfort (2003b). Hydrogen/CNG Blended Fuels: Performance Testing in a Ford F-150. Advanced Vehicle Testing Activity, INEEL/EXT-03-01313. Idaho Falls, USA, U.S. Department of Energy - Idaho National Laboratory.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Compressed natural gas with 15 % hydrogen	Input	Refined resource	HCNG-15	5.64			MJ	Technosphere	
	Output	Emission	CH4	0.082			g	Air	Arizona
	Output	Emission	CO	0.29			g	Air	Arizona
	Output	Emission	CO2	281			g	Air	Arizona
Notes: total hydrocarbons	Output	Emission	HC	0.111			g	Air	
Notes: Non-methane hydrocarbons	Output	Emission	NMHC	0.00155			g	Air	
	Output	Emission	NOx	0.0771			g	Air	Arizona

About Inventory	
Publication	This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf
Intended User	LCA practitioners.
General Purpose	This data set is included in a master thesis. Excerpt from the master thesis abstract: ''Hydrogen is often considered as the way out of the environmental and economical problems associated with the use of fossil fuels. However, one of the main implementation barriers is the missing infrastructure. The introduction of hydrogen-blended compressed natural gas (HCNG) as a fuel for natural gas vehicles could serve as a bridging technology by using the existing natural gas infrastructure for the distribution of hydrogen.''
Detailed Purpose	Excerpt from the master thesis abstract: ''The purpose of this thesis is to assess and compare the environmental aspects of using natural gas, HCNG with 15% and 30% hydrogen by volume, and hydrogen as vehicle fuels within the scope of the proposed demonstration project.'' Excerpt from the report (see 'Publication'): ''Since 2001, the Arizona Public Service (APS), in cooperation with Electric Transportation Applications (ETA) and the U.S. Department of Energy's Advanced Vehicle Testing Activity (ATVA), has tested different vehicles operated on CNG, HCNG and hydrogen.''
Commissioner	Not applicable - .
Practitioner	Daniel Kilgus - .
Reviewer	Karl Jonasson -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpt from the report (see 'Publication'): ''Since 2001, the Arizona Public Service (APS), in cooperation with Electric Transportation Applications (ETA) and the U.S. Department of Energy's Advanced Vehicle Testing Activity (ATVA), has tested different vehicles operated on CNG, HCNG and hydrogen. Although the tested vehicles are not commonly found on Swedish roads, the test results were used since it is assumed that comparable results of other vehicle types would mainly differ by quantity.'' ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-11-16 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Modified natural gas vehicle (NGV) operating on CNG with 30 % hydrogen (HCNG-30). ESA-DBP

Administrative	
Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System

Name	Modified natural gas vehicle (NGV) operating on CNG with 30 % hydrogen (HCNG-30). ESA-DBP
Functional Unit	1 vehicle km
Functional Unit Explanation	
Process Type	Gate to gate
Site	Unknown
Sector	Land transport
Owner	Unknown
Technical system description	Ford F-150 pickup truck. Excerpts from the report (see 'Publication'): ''The test vehicle was operated on 100% CNG and blends of 15 and 30% HCNG. The test conditions and results are given in Karner and Francfort (2003b). Unlike the Dodge Ram Wagon Van, the Ford F-150 test vehicle is equipped with a factory CNG engine that is modified to run on blends of CNG and up to 30% hydrogen by volume. The modifications include supercharging, ignition modifications, and exhaust gas recirculation. The emission measurements were also performed according to the Federal Test Procedure (FTP-75).'' This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf Other processes in the CPM Database also included in the above publication: 'Extraction and processing of natural gas (NG). ESA-DBP' 'Unmodified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP' 'Unmodified natural gas vehicle (NGV) operating on CNG wiith 15 % hydrogen (HCNG-15). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on CNG wiith 15 % hydrogen (HCNG-15). ESA-DBP'

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	Data monitored in 2003.
Geographical Boundary	Test made in Arizona, USA.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2003
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	The emission measurements were performed according to the Federal Test Procedure (FTP-75). This test consists of three phases (cold start, transient and hot start), which cover 1,874 seconds and 17.77 kilometres at an average speed of 33.96 km/h.
Literature Reference	Karner, D. and J. E. Francfort (2003b). Hydrogen/CNG Blended Fuels: Performance Testing in a Ford F-150. Advanced Vehicle Testing Activity, INEEL/EXT-03-01313. Idaho Falls, USA, U.S. Department of Energy - Idaho National Laboratory.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*

Notes: Compressed natural gas with 30 % hydrogen	Input	Refined resource	HCNG-30	5.43			MJ	Technosphere	United States
	Output	Emission	CH4	0.0857			g	Air	Arizona
	Output	Emission	CO	0.263			g	Air	Arizona
	Output	Emission	CO2	278			g	Air	Arizona
Notes: total hydrocarbons	Output	Emission	HC	0.109			g	Air	Arizona
Notes: Non-methane hydrocarbons	Output	Emission	NMHC	0.00808			g	Air	Arizona
	Output	Emission	NOx	0.0783			g	Air	Arizona

About Inventory

Publication	This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf
Intended User	LCA practitioners.
General Purpose	This data set is included in a master thesis. Excerpt from the master thesis abstract: ''Hydrogen is often considered as the way out of the environmental and economical problems associated with the use of fossil fuels. However, one of the main implementation barriers is the missing infrastructure. The introduction of hydrogen-blended compressed natural gas (HCNG) as a fuel for natural gas vehicles could serve as a bridging technology by using the existing natural gas infrastructure for the distribution of hydrogen.''
Detailed Purpose	Excerpt from the master thesis abstract: ''The purpose of this thesis is to assess and compare the environmental aspects of using natural gas, HCNG with 15% and 30% hydrogen by volume, and hydrogen as vehicle fuels within the scope of the proposed demonstration project.'' Excerpt from the report (see 'Publication'): ''Since 2001, the Arizona Public Service (APS), in cooperation with Electric Transportation Applications (ETA) and the U.S. Department of Energy's Advanced Vehicle Testing Activity (ATVA), has tested different vehicles operated on CNG, HCNG and hydrogen.''
Commissioner	Not applicable - .
Practitioner	Daniel Kilgus - .
Reviewer	Karl Jonasson -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpt from the report (see 'Publication'): ''Since 2001, the Arizona Public Service (APS), in cooperation with Electric Transportation Applications (ETA) and the U.S. Department of Energy's Advanced Vehicle Testing Activity (ATVA), has tested different vehicles operated on CNG, HCNG and hydrogen. Although the tested vehicles are not commonly found on Swedish roads, the test results were used since it is assumed that comparable results of other vehicle types would mainly differ by quantity.'' ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-11-16 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Modified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP

Administrative

Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System

Name	Modified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP
Functional Unit	1 vehicle km
Functional Unit Explanation	Not applicable.
Process Type	Gate to gate
Site	Unknown
Sector	Land transport
Owner	Unknown
Technical system description	Ford F-150 pickup truck. Excerpts from the report (see 'Publication'): ''The test vehicle was operated on 100% CNG and blends of 15 and 30% HCNG. The test conditions and results are given in Karner and Francfort (2003b). Unlike the Dodge Ram Wagon Van, the Ford F-150 test vehicle is equipped with a factory CNG engine that is modified to run on blends of CNG and up to 30% hydrogen by volume. The modifications include supercharging, ignition modifications, and exhaust gas recirculation. The emission measurements were also performed according to the Federal Test Procedure (FTP-75).'' This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf Other processes in the CPM Database also included in the above publication: 'Extraction and processing of natural gas (NG). ESA-DBP' 'Unmodified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP' 'Unmodified natural gas vehicle (NGV) operating on CNG wiith 15 % hydrogen (HCNG-15). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on CNG wiith 15 % hydrogen (HCNG-15). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on CNG wiith 30 % hydrogen (HCNG-30). ESA-DBP'

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	Data monitored in 2003.
Geographical Boundary	Test made in Arizona, USA.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2003
Data Type	Monitored data, discrete
Represents	See 'Function'.

Method	The emission measurements were performed according to the Federal Test Procedure (FTP-75). This test consists of three phases (cold start, transient and hot start), which cover 1,874 seconds and 17.77 kilometres at an average speed of 33.96 km/h.
Literature Reference	Karner, D. and J. E. Francfort (2003b). Hydrogen/CNG Blended Fuels: Performance Testing in a Ford F-150. Advanced Vehicle Testing Activity, INEEL/EXT-03-01313. Idaho Falls, USA, U.S. Department of Energy - Idaho National Laboratory.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Compressed natural gas	Input	Refined resource	CNG	5.48			MJ	Technosphere	
	Output	Emission	CH4	0.0795			g	Air	Arizona
	Output	Emission	CO	0.352			g	Air	Arizona
	Output	Emission	CO2	294			g	Air	Arizona
Notes: total hydrocarbons	Output	Emission	HC	0.107			g	Air	
Notes: Non-methane hydrocarbons	Output	Emission	NMHC	0.0143			g	Air	
	Output	Emission	NOx	0.0684			g	Air	Arizona

About Inventory

Publication	This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf
Intended User	LCA practitioners.
General Purpose	This data set is included in a master thesis. Excerpt from the master thesis abstract: ''Hydrogen is often considered as the way out of the environmental and economical problems associated with the use of fossil fuels. However, one of the main implementation barriers is the missing infrastructure. The introduction of hydrogen-blended compressed natural gas (HCNG) as a fuel for natural gas vehicles could serve as a bridging technology by using the existing natural gas infrastructure for the distribution of hydrogen.''
Detailed Purpose	Excerpt from the master thesis abstract: ''The purpose of this thesis is to assess and compare the environmental aspects of using natural gas, HCNG with 15% and 30% hydrogen by volume, and hydrogen as vehicle fuels within the scope of the proposed demonstration project.'' Excerpt from the report (see 'Publication'): ''Since 2001, the Arizona Public Service (APS), in cooperation with Electric Transportation Applications (ETA) and the U.S. Department of Energy's Advanced Vehicle Testing Activity (ATVA), has tested different vehicles operated on CNG, HCNG and hydrogen.''
Commissioner	Not applicable - .
Practitioner	Daniel Kilgus - .
Reviewer	Karl Jonasson -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpt from the report (see 'Publication'): ''Since 2001, the Arizona Public Service (APS), in cooperation with Electric Transportation Applications (ETA) and the U.S. Department of Energy's Advanced Vehicle Testing Activity (ATVA), has tested different vehicles operated on CNG, HCNG and hydrogen. Although the tested vehicles are not commonly found on Swedish roads, the test results were used since it is assumed that comparable results of other vehicle types would mainly differ by quantity.'' ____ ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-11-16 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Mounting of bearing

Administrative	
Finished	Y
Date Completed	2002-12-
Copyright	
Availability	

Technical System	
Name	Mounting of bearing
Functional Unit	1.2 ton of bearing
Functional Unit Explanation	One SKF spherical roller bearing size 232/530 weighs 1.2 ton.
Process Type	Unit operation
Site	Stora Enso Hylte ABHylte Mill S- 314 81 HYLTEBRUK Sweden
Sector	Construction
Owner	Stora Enso Hylte ABHylte Mill S- 314 81 HYLTEBRUK Sweden
Technical system description	This activity describes Mounting of bearing. The bearing is mounted on a soft calender roll at Stora Enso, using a manual hydraulic pump and a small amount of lubricant.

System Boundaries	
Nature Boundary	Neither the bearings or the lubricant enters from or leaves to the nature. Emissions are not included due to lack of data.
Time Boundary	Data is collected autumn 2002. Mounting of a bearing takes place every 4.5 year at Hyltebruk.
Geographical Boundary	This mounting procedure is performed at Storaenso at Hyltebruk, Sweden.
Other Boundaries	Manufacturing of lubricant is not included.
Allocations	See Notes in Flow Meta Data.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData	
Date Conceived	2002-09-01 - 2002-12-31
Data Type	Unspecified, expert outspoke
Represents	N/A
Method	Data is gathered from interviews with Dan Hedin and Bernt Petersson at Storaenso, Hyltebruk.
Literature Reference	N/A
Notes	Mounting fluid used to facilitate the mounting.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: One SKF bearing 232/530 weighs 1.2 ton.	Input	Refine resource	Bearing	1.2			tonne	Technosphere	Sweden
Notes: Mounting fluid used to facilitate the mounting. The mounting is performed every 4.5 year in mean, consuming 1 dl mounting fluid of density	Input	Refine resource	SKF LHMF 300	0.1788			kg	Technosphere	Sweden

0.894 kg/l.									
Notes: One SKF bearing 232/530 weighs 1.2 ton.	Output	Residue	Bearing	1.2			tonne	Technosphere	Sweden
Notes: Mounting fluid used to facilitate the mounting. The mounting is performed every 4.5 year in mean, consuming 1 dl mounting fluid of density 0.894 kg/l.	Output	Residue	SKF LHMF 300	0.1788			kg	Technosphere	Sweden

About Inventory	
Publication	
Intended User	Product developer at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The purpose for our study is to compare a coated roller bearing to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	All bearings mounted on a soft calender in a paper machine where lubricant is needed.
About Data	Data is gathered from interviews with Dan Hedin and Bernt Petersson at Storaenso, Hyltebruk.
Notes	

SPINE LCI dataset: Mounting profile production

Administrative	
Finished	Y
Date Completed	1996-10-01
Copyright	
Availability	Public

Technical System	
Name	Mounting profile production
Functional Unit	kg
Functional Unit Explanation	1 kg mounting profile
Process Type	Gate to gate
Site	Plannja AB Svartön, Svartövägen 1 971 88 Luleå Sweden
Sector	Materials and components
Owner	Plannja AB Svartön, Svartövägen 1 971 88 Luleå Sweden
Technical system description	Dipgalvanized steel coils and aluminum coils is painted and profiled. In the production process, sheet metal is processed into trapezium sheet metal (read mounting profile) for use as constructional members and as wall and roof covering in both domestic and industrial buildings. Train to the plant delivers hot dipgalvanized steel coils and aluminum coils, where it is painted and profiled (transports are not considered in this set of data). About 90% the total production (both steel and aluminum) is painted. Steel is the most important raw material in the process; aluminum stands for about 6% of the

	weight of total production.

System Boundaries

Nature Boundary	Emissions to air and water Emissions to air are omitted since they occur mainly from the painting process and the product of this study is assumed not to be painted. Flue gases are incinerated. Emissions to water are regarded as negligible.
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	The environmental load for chemicals and electricity is not traced back to the cradle.
Allocations	The environmental impact is equally distributed on produced weight of trapezium sheet metal (including both aluminum and steel sheets).
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Estimated from similarity
Represents	The data for mounting profile has been approximated with the production of trapezium sheet steel.
Method	Study of the environmental report
Literature Reference	Environmental Report 1994, Plannja AB, Luleå, 1995
Notes	The data is taken from the Environmental Report for Plannja AB 1994.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Chemicals	6.49			g	Technosphere	
	Input	Refined resource	Electricity	0.552			MJ	Technosphere	
	Input	Refined resource	Gas	1.42			MJ	Technosphere	
	Input	Refined resource	Heat	0.361			MJ	Technosphere	
	Input	Refined resource	Sheet steel	1010			g	Technosphere	
	Input	Refined resource	Steam	0.100			MJ	Technosphere	
	Output	Product	Mounting profile	1			kg	Technosphere	
	Output	Residue	Industrial waste	14.0			g	Technosphere	

About Inventory

Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden -- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology --
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural concrete and steel frames in buildings during the whole life cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of mounting profile
Commissioner	- Finncement and Trätek (The Swedish Institute for Wood Technology Research) Box 5609 S-114 86 Stockholm Sweden.
Practitioner	Björklund T., Jönsson Å., Tillman A-M - Technical Environmental Planning, CTH Sven Hultins Gata 8 412 96 Göteborg Sweden .
Reviewer	

Applicability	The environmental load for Z-profile can be approximated with the one for mounting profile. To calculate the total environmental load for mounting profile, including the sheet steel production, you can use the data in this Database at: Name: Swedish sheet steel mix Category: Other Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden
About Data	Raw materials SSAB Tunnplåt delivers 95% of the hot dipgalvanized steel coils, and it is assumed in the calculations that all steel coils come from SSAB Tunnplåt. It is assumed that no paint is used for trapezium sheet steel in light decks, and paints used in the process are therefore omitted. The most important chemicals used in this process are bounders, flocculation chemicals, sulphuric acid and lubricants. Chemicals are regarded as non-elementary flows. All steel scrap (about 1% of incoming raw materials) goes back to SSAB Tunnplåt for recycling and is therefore not included. Energy use Steam and hot water is externally produced. For estimating the energy use of steam production an energy use of 2.26 MJ/kg is assumed, which is the entalphy for steam production from water. Transports The steel sheets are transported from SSAB Tunnplåt in Borlänge to Luleå by railway, and the distance is estimated to 865 km. It is not considered in this set of data.
Notes	

SPINE LCI dataset: Natural gas fired combination plant for heat and power production

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Natural gas fired combination plant for heat and power production
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the combustion process in a natural gas fired combination plant for heat and power production in Sweden. The plant consists of one gas turbine, one steam boiler and one back pressure steam turbine. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hour): 8 285 Total electric power output (MW): 8,2 Total thermal output (MW): 51 Annual total use of fuel (MWh): 247 190 Normal annual production of heat (MWh): 212 000

	Normal annual production of electricity (MWh): 24 000 Degree ofthermal effieciency (%): 95 PROCESS DESCRIPTION: The unit consists of one gas tubine, one steam boiler and one back pressure steam turbine. The gas turbine is equiped with water injection and the burner of the boiler has a shape that keep the emission of NOx low. The maximum thermal output is 51 MW. The heat is delivered to a district heating net. INCLUDED OPERATIONS: The process study consists of the following operations: - The feeding of the natural gas into the combustion process. - The combustion process. - The production of heat (and electricity). - The internal consumption of electricity. - The NOx control system. NOx CONTROL SYSTEM: The burner of the boiler is of low-NOx type, which yields a low NOx-value (in this case 65 mg/MJ). OTHER FLUE GAS CLEANING SYSTEMS: Combustion of natural gas will not give rise to any sulphur or dust emissions. The plant is therefor not equipped with any further gas cleaning system.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. According to experience the emission of HC are close to zero (not measurable) when natural gas is fired.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data from 1996. The data consist of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION: This inventory has been conducted on a natural gas fired plant for heat and power production in Sweden, with swedish regulaitons, applicable during 1996. The collected data should only be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat and electricity from the plant to the consumers. - Building of the plant, the district heating net or the electricity supply system. - The cradle to gate of the internal electricity consumption. - The production of natural gas. - The transportation of natural gas to the plant. EXCLUDED FLOWS - The chemicals used for feed water treatment. - The water consumption in the process.
Allocations	PRINCIPLE APPLIED: In a combined heating and power plant two products of economic value are produced, heat and electrical power. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat and power respectively. For the use of resources and emissions that are specific for the electrical power production are allocated to that production. Equivalent to this the use of resources and emissions specific for the heat production are allocated to that product. Note: When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	The data for mounting profile has been approximated with the production of trapezium sheet steel.

Method	All data reported are related to the functional unit 1 kWh heat produced and delivered. The data is originally given as total yearly amount of an input (fuel, electricity etc.) to or an output (emission, product) from the energy plant. The inputs and outputs are the related to the functional unit by dividing the total yearly amount with the yearly amount of produced heat and multiplying with the fraction of the total production that are associated with the heat production. For some flows specific information is given, see each flow.
Literature Reference	Data is in general recieved from ''Miljörapport 1996, Vattenfall AB värme västsverige''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Method: Not known	Input	Refined resource	Electricity	0.00294			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Ion exchanger	0.00169			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Natural gas	83.2			g	Technosphere	
Data type: Monitored data, continuous Method: This emission is measured continously. Literature: Miljörapport 1996, Vattenfall AB, värme västsverige	Output	Emission	CO	0.00604			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with natural gas, according to NUTEK. The standard value for natural gas is 56 g/MJ fuel.	Output	Emission	CO2	211			g	Air	
Notes: No dust is emitted from the combustion of natural gas.	Output	Emission	Dust	0			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continously. Literature: Miljörapport 1996, Vattenfall AB, värme västsverige	Output	Emission	NOx	0.245			g	Air	
Notes: Natural gas contains no sulphur.	Output	Emission	SO2	0			g	Air	
	Output	Product	Heat	1			kWh	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended users of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose was to compare data from plants producing heat with various fuels, combustion technologies and flue gas systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conduced using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden. The data for this system should only be used on plants in Sweden and for swedish conditions and regulations. When both heat and power are produced the allocation between the products are the same.

	That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.
Notes	

SPINE LCI dataset: Natural gas fired combination power plant with support systems

Administrative	
Finished	Y
Date Completed	1996-12-01
Copyright	
Availability	Public

Technical System	
Name	Natural gas fired combination power plant with support systems
Functional Unit	Net production of 1 kWh electricity
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the production of 1 kWh electricity.
Process Type	Cradle to gate
Site	
Sector	Grid electricity and district heat
Owner	
Technical system description	The studied system include *extraction and transport of natural gas and operation and maintenance of a modern natural gas fired combination power plant.* The plant uses a combination of gas turbine and steam turbine. A combination plant has a significantly higher degree of efficiency than both a conventional gas turbine and a power plant with a conventional steam turbine. The fuel is extracted in the North sea. Production of materials, chemicals and electricity and transports, used in association with the fuel chain and the operation and maintenance of the plant are included. The *fuel production* include extraction of natural gas from the Norwegian Ekofisk-field, maintenance and reinvestments of the oil platform and compression and transport of the natural gas in pipe line to the power plant. The share of construction and maintenance of the Danish pipe-line Nybro-Dragör (20 %) and the Swedish pipe line Dragör-Varberg (40%) that can be assigned to the gas combination power plant have also been included. Light weight oil are assumed as *reserve fuel and emergency fuel*. Oil are only used in exceptional cases, at disturbances in the supply of natural gas or inspection of the natural gas system; on average 100 hours per year. The power plant will not operate on oil and natural gas simultaneously. *Technical data* for the studied plant: Time of use, recalculated to full effect (hours): 7000 Supplied fuel effect (MW): 877 Annual total fuel use (TWh): 6,14 Normal annual production of electricity (GWh): 3255 Assumed life-time (years): 40

	Electricity production, net during 40 years (TWh): 130,2 Degree of efficiency (%): 53

System Boundaries	
Nature Boundary	The analysis starts at the *extraction of natural gas*. The gas is then followed through pipe-lines to the plant. All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The power plant is assumed to operate during 40 years.
Geographical Boundary	The power plant are located in the south-west of Sweden. The fuel used in the plant are extracted from the Norwegian continental-shelf and transported to the and pipe-line to the power plant.
Other Boundaries	The studied system include *extraction and transport of natural gas and operation and maintenance of a natural gas fired combination plant.* Calculations of building and demolition of the plant has been performed but are not included in this system. ***Sub-systems included in the studied system:*** • Use of resources and emissions associated with reinvestments and reconstruction. Concrete constructions and buildings are however not considered to need renewal during the lifetime of the power station. • Emissions to air and water and use of energy and materials, and rest products in association with drilling and extraction of gas and maintenance and reinvestments of the oil platform. • Energy use and emissions in association with compression and transport of the natural gas in pipe line. • The share of construction and maintenance of the Danish pipe-line Nybro-Dragör (20 %) and the Swedish pipe line Dragör-Varberg (40%) that can be assigned to the gas combination power plant. • Known use of chemicals are accounted for. In the cases where it was possible to obtain data, resource use and emissions for the production are included. • Use of resources and emissions to air from production of the electricity that is used in the life cycles. • Energy use and emissions for the production of oil for the studied manufacturing processes and transports. ***Sub-systems excluded from the system:*** • Construction and demolition of plants and production platforms and pipe-lines from Norway to Denmark. • Prospecting of gas and construction of platforms and existing gas pipe-lines in the North sea. • Equipment after the power station transformer are not included. • Waste and rest products are transported to final waste. Operation and chemical and biological decomposing processes (nedbrytningsprocesser) in the final waste have not been considered. • The risk of major accidents and rare breakdowns and environmental consequences from these. • Work environment. • Environmental loads caused by the operation personnel.

Allocations	The *50/50 method* has been applied throughout the calculations. The method is described in ''Nordic Guidelines on Life-Cycle Assessment'', Nord 1995:20, The Nordic Council, Stockholm.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	The data for mounting profile has been approximated with the production of trapezium sheet steel.
Method	An analysis of the fuel production, operation and maintenance of a gas-fired combination plant
Literature Reference	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', in Swedish, Vattenfall AB
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate. Combustion of gas are responsible for the largest share of emissions of CO2 and NOx during operation of the plant. Steel and copper are replaced, and the manufacture of these materials and ammonia are responsible for a large share of NOx, SO2 and CO2 emissions. Production of ammonia is very energy demanding. The production of natural gas causes relatively large emissions. The emissions of NOx from fuel production are actually larger than from the operation of the plant.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Area	.000082			m2	Ground	
	Input	Natural resource	Bauxite	.000065			g	Ground	
	Input	Natural resource	Bio fuel	.000019			kWh	Other	
	Input	Natural resource	Coal	.000764			kWh	Other	
	Input	Natural resource	Copper ore	.070300			g	Ground	
	Input	Natural resource	Heavy oil	.028400			kWh	Ground	
	Input	Natural resource	Iron ore	.213000			g	Ground	
	Input	Natural resource	Natural gas	.035800			kWh	Other	
Notes: Fuel used in the plant.	Input	Natural resource	Natural gas	1.890000			kWh	Ground	
	Input	Natural resource	Wood	.000077			g	Ground	
Notes: Have not been traced back to the cradle	Input	Refined resource	Ammonia	.614000			g	Technosphere	
Notes: Electricity produced by nuclear power. For the production of 1 kWh electricity in a nuclear power plant, 1,24 g uranium ore is used.	Input	Refined resource	Electricity	.000163			kWh	Technosphere	
Notes: Electricity produced by water power.	Input	Refined resource	Electricity	.000247			kWh	Technosphere	
Notes: Includes oil, gasoline, diesel, lubricating- and transformer oil.	Input	Refined resource	Heavy oil	.005810			kWh	Technosphere	
Notes: Have not been traced back to the cradle	Input	Refined resource	NaOH	.038400			g	Technosphere	
Notes: Have not been traced back to the cradle	Input	Refined resource	Nitric acid	.001490			g	Technosphere	
Notes: There are data gaps for e.g. the production of copper and cement.	Output	Emission	CO	.102000			g	Air	
	Output	Emission	CO2	422.000000			g	Air	
Notes: There are data gaps for e.g. the production of copper and cement and combustion.	Output	Emission	HC	.019800			g	Air	
	Output	Emission	NOx	.199000			g	Air	

Notes: There are data gaps for e.g. the production of copper, cement and lubricating oil.	Output	Emission	N-tot	.000018			g	Water	
Notes: There are data gaps for e.g. the production of lubricating oil.	Output	Emission	Particles	.000852			g	Air	
	Output	Emission	SO2	.006540			g	Air	
	Output	Product	Electricity	1.000000			kWh	Technosphere	
Notes: Includes rest products from fuel extraction and production of materials and chemicals, replaced material, material to final waste and fully operational gas pipe-lines. These leave the system after the studied time of 60 years.	Output	Residue	Other rest products	0.143			g	Technosphere	

About Inventory

Publication	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	The data can be used as a basi
General Purpose	• The work with life-cycle analysis are expected to *contribute to a reinforcement and structuring* of the environmental work within Vattenfall, and a deeper knowledge on the use of resources and emissions to the environment. • An LCA can *facilitate a need for reliable data for electricity production.* Electricity is used in the manufacture of almost every product, and data from an LCA can be used when conducting an LCA on products. • An LCA can *facilitate a choice between different techniques* for future electricity production. • An LCA can also help to *choose the most effective alternatives* to reduce the consumption of resources and environmental influence of the current electricity production system. • It is also possible to *compare* the environmental load for different alternatives of electricity production.
Detailed Purpose	To obtain a *reliable basis* to be able to perform life-cycle analyses of different types of electricity use, and to identify opportunities for improvements in the existing system. To identify data gaps and areas where the knowledge are poor.
Commissioner	- Vattenfall Elproduktion .
Practitioner	- Vattenfall Energisystem AB: Britt-Marie Brännström-Norberg Ulrika Dethlefsen Roland Johansson Caroline Setterwall Sofie Tunbrant .
Reviewer	- Thomas Ekvall, Chalmers Industriteknik (CIT) Gunnar Lindfors, Institutet för Vatten- och Luftvårdsforskning (IVL) Göran Finnveden, Institutet för Vatten- och Luftvårdsforskning (IVL)
Applicability	The studied system include extraction and transport of natural gas and operation and maintenance of a natural gas fired combination plant. The choice of the plant and technique studied make the analysis *representative for the operation and maintenance of a modern natural gas fired combination power plant.* The plant uses a combination of gas turbine and steam turbine. A combination plant has a significantly higher degree of efficiency than both a conventional gas turbine and a power plant with a conventional steam turbine. The choice of emission data has a major influence on the result. This is determined at the permit consideration for a plant and varies between both plants and countries. Relatively strict regulations have been chosen and a high but realistic degree of efficiency. Transmission and distribution losses are not included. When the result is used to study different types of electricity use, these losses should be included. A rough estimate are that the distribution losses for a large industry customer are approximately 5% of the bought electricity, i.e. to obtain data for the use of electricity the data should be multiplied with 1,05. For an average household customer the

	transmission losses are approximately 10% of the bought electricity, i.e. the data should be multiplied with 1,10. The fuel is *extracted in the North sea.* The data used for the extraction of gas are representative of the Norwegian gas fields in use today. The data for Norwegian gas extraction will however not be representative for the power plants in use in 2000. The gas field opened in 1995 will account for the larger share of future Norwegian gas deliveries. Emissions of CO2 and NOx per produced energy gas from Norwegian gas fields in 2000 are assumed to be reduced with 35% and 25% respectively, in relation to the data from 1991. The complete study include building, operation and maintenance, and demolition of the power plant and fuel production. When the data is used for energy production in a life cycle analysis of a product or a system, that do not require expansion of the electricity production system, it however reasonable only to include fuel production and operation and maintenance. The other phases of the life cycle are the same independent on the electricity production.
About Data	Errata: According to Vattefall, the fuel chain has been miscalculated. Transports have been accounted for twice. No corrections have yet been made to the database, but will be inserted as soon as the correct calculation have been obtained from Vattenfall. Data for the use of resources and energy for operation of the power stations are specific for one of Vattenfall¦s prospected gas combination power plants. The fuel are assumed to consist of a quality equivalent to the quality of the natural gas extracted from the Norwegian Ekofisk-field. Light weight oil have been assumed as reserve fuel and emergency fuel. Relevant data for transports, extraction and production of metals and chemicals, and manufacture and work on important components were hard to obtain. Data from manufacturers and other reports and studies, primarily life cycle analyses have been used. Production of material and transports are considered with current technology. Swedish standard values have been used to calculate fuel use and emissions from transports. Transport distances are specific for the operation of the plant. *The parameters that are presented* are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate. Use of resources and emissions associated with *reinvestments and reconstruction* are generally assumed to give an addition of 1 % per year of the use of resources and emissions at the building phase. Concrete constructions and buildings are however not considered to need renewal during the lifetime of the power station. The following data has been used in the analysis (tonnes per year during 40 years): Steel. 48,80 Copper: 4,0 Stone wool: 2,1 Titanium: 4,4 Aluminium: 0,25 PVC: 0,29 Ammonia: 2000 The value have been corrected from the report. Hydrazine: 8,0 Hydrochloric acid (30%): 0,025 Sodium hydroxide (45%): 1,0 Iron chloride (12%): 20,0 Polymers: 30,0 The following *emission factors* have been assumed to calculate the emissions to air from operation of the power plant: NOx: 10,00 mg/MJ; 6,80e-2 g/kWh produced electricity SO2: 0,40 mg/MJ; 2,72e-3 g/kWh produced electricity CO: 10,00 mg/MJ; 6,80e-2 g/kWh produced electricity Particles (reserve fuel): 3,00 mg/MJ; 2,98e-4 g/kWh produced electricity CO2: 57000 mg/MJ; 3,87e2 g/kWh produced electricity NH3: 2,20 mg/MJ; 1,50e-2 g/kWh produced electricity CH4: 2,00 mg/MJ; 1,36e-2 g/kWh produced electricity For electricity used in the manufacture of materials and fuels, *average electricity* for the respective countries distributed on the different electricity production alternatives have been used. The following degrees of efficiencies have been used to calculate the fuel used in the electricity production. The values are standard values for existing power plants. New modern plants have often higher degrees of efficiencies. The values are calculated from the effective heat value in the used

	fuels and the energy content in the steam produced in a nuclear power plant. • Coal condensing: 40% • Oil condensing: 40% • Natural gas condensing/combination: 40% • Gas turbine: 25% • Combined heat and power plant(irrespective of fuel) 30% (for electricity production) 85% (total, for electricity and heat production) • Water power: are not recalculated, are accounted for as kWh electricity • Nuclear power: 33%, are however not recalculated, but accounted for as kWh electricity or gram natural uranium.
Notes	

SPINE LCI dataset: Natural gas fired plant for heat production - Small plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Natural gas fired plant for heat production - Small plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a natural gas fired plant for heat production. Heat is produced and delivered to a district heating net. Production of materials, chemicals, electricity and transport, used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): 8460 Total thermal output (MW): 3,5 Annual total fuel use (MWh): 8 350 Normal annual production of heat (MWh): 7 920 Degree of thermal efficiency (%): 95 PROCESS DESCRIPTION: The unit consists of a steam boiler for heat production. The maximum thermal output is 3,5 MW. No activities has been made for reducing the NOx emission. INCLUDED OPERATIONS:

	The process studied consists of the following operations: - The feeding of the natural gas into the combustion process. - The combustion process. - The production of heat. - The internal consumption of electricity. NOx CONTROL: The boiler is not equiped with any NOx control system. OTHER FLUE GAS CLEANING SYSTEMS: Natural gas leaves no sulphur oxides or dust as emissions and therfore no cleaning of the flue gas is done.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. According to experience the emission of HC are close to zero (not measurable) when natural gas is fired.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION: This inventory has been conducted on a natural gas fired plant for heat production in Sweden, with swedish regulations, applicable during 1996. The collected data should only be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant, the district heating net and the electricity supply system. - The cradle to gate of the internal electricity consumption. - The production of natural gas. - The transportation of natural gas to the plant. EXCLUDED FLOWS - The chemicals for feed water treatment. - The water consumption in the process.
Allocations	PRINCIPLE APPLIED: In a heating plant one product of economic value is produced. For operation and maintenance of the plant the use of resources and the emissions are associated with the net production of heat. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	The data for mounting profile has been approximated with the production of trapezium sheet steel.
Method	All data reported are related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amount of an input (fuel, chemical, electricity etc.) to or an output (emission, product) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the total yearly amount with the yearly amount of produced heat. For some flows specific information is given, see each flow.
Literature Reference	Data are in general recieved from ''Miljörapport 1996, Göteborg Energi AB''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: The consumed amount for the year.	Input	Refined resource	Natural gas	83.2			g	Technosphere	

Method: The consumed amount for the year.	Input	Refined resource	Trisodium phosphate	0.00184			g	Technosphere	
Method: Not known.	Output	Emission	CO	0.0269			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with natural gas, according to NUTEK. The standard value for natural gas is 56 g/MJ fuel.	Output	Emission	CO2	215			g	Air	
Notes: No dust is emitted from the combustion of natural gas.	Output	Emission	Dust	0			g	Air	
Method: According to experience the emission of HC are close to zero (not measurable) when natural gas is fired.	Output	Emission	HC	0			g	Air	
Method: Not known.	Output	Emission	NOx	0.0919			g	Air	
Notes: Natural gas contains no sulphur.	Output	Emission	SO2	0			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose was to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1996. The data consists of ????. This data is assumed to be valid until new national or local regulations are enforced in Sweden. The data for this system should only be used on plants in Sweden and for swedish conditions and regulations.
About Data	GENERAL DATA SOURCE DESCRIPTION:
Notes	

SPINE LCI dataset: Natural gas fired plant with flue gas condensation for heat and power production

Administrative

Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System

Name	Natural gas fired plant with flue gas condensation for heat and power production
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a modern natural gas fired plant for heat and power production in Sweden. The plant consists of two steam boiler units and is also equipped with a flue gas condensation system, to recieve more heat from the fuel. The heat is delivered to a district heating net. The plant also produces some electricity. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): 4141 Total electric power output (MW): 21+14 Total thermal output (MW): 43+42 Flue gas condensation capacity (MW): 15 Annual total fuel use (MWh): 517 469 Normal annual production of electricity (GWh): 110 919 Normal annual production of heat (GWh): 386 658 Degree of thermal efficiency (%): 96 PROCESS DESCRIPTION: The natural gas is incinerated in two steam boiler units. Steam is produced and transformed into electricity in a steam turbine/generator and into heat in a condensor and in some other steps. Some heat is also generated in the flue gas condensation system, when the moisture in the fuel condensates. Oil is used as reserve fuel, but is not included in this system. INCLUDED OPERATIONS: The process study consists of the following operations: - The feeding of the natural gas into the combustion process. - The combustion process. - The production of heat and (electricity). - The internal consumption of electricity. - The NOx contorl system. NOx CONTROL: The burners of the boilers are of low-NOx type, which yields a low NOx-value. OTHER FLUE GAS CLEANING SYSTEMS: Natural gas leaves no sulphur oxides or dust as emissions and therefore no cleaning of the flue gas is done.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. According to experience the emission of HC are close to zero (not measurable) when natural gas is fired.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data from 1996. The data consist of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION: This inventory has been conducted on a natural gas fired plant for heat production in Sweden, with swedish regulations, applicable during 1996. The collected data should only be used for swedish conditions.

Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: -The use of reserve fuel (oil). -The distribution of district heat and electricity from the plant to the consumers. -Building of the plant, the district heating net or the electricity supply system. -The cradle to gate of the internal electricity consumption. -The production of natural gas. -The transportation of natural gas to the plant. EXCLUDED FLOWS -The water consumption in the processes.
Allocations	PRINCIPLE APPLIED: In a combined power and heating plant two products of economic value are produced. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat and power respectively. For the use of resources and emission that are specific for the electric power production are allocated to that production. Equivalent to this the use of resources and emissions specific for heat production are allocated to that production. Note: When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	The data for mounting profile has been approximated with the production of trapezium sheet steel.
Method	All data reported is related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amount of an input (fuel, chemical, electricity etc.) to or an output (emission, product) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the total yearly amount with the yearly amount of produced heat and multiplying with the fraction of the total production that are associated with the heat production. For some flows specific information is given, see each flow.
Literature Reference	Data are in general recieved from ''Miljörapport 1996, Göteborg Energi AB''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: Not known.	Input	Refined resource	Electricity	0.00104			kWh	Technosphere	
Method: The consumed amount for the year. Notes: The amount is given as a solution of 30 weight percent.	Input	Refined resource	Hydrochloric acid	0.0000241			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Ion exchanger	0.00169			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Morpholine	0.000137			g	Technosphere	
Method: The consumed amount for the year. Notes: The amount is given as a solution of 50 weight percent.	Input	Refined resource	NaOH	0.0000181			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Natural gas	79.4			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Trisodium phosphate	0.000201			g	Technosphere	
Data type: Monitored data, continuous Method: This emission is measured continously. Literature: Miljörapport 1996, Göteborg Energi AB	Output	Emission	CO	0.00666			g	Air	

Method: The yearly amount of this emission was estimated by using the standard vaklue for CO2-emissions from plants fired with natural gas, according to NUTEK. The standard value for natural gas is 56 g/MJ fuel.	Output	Emission	CO2	210			g	Air	
Notes: No dust is emitted from the combustion of natural gas.	Output	Emission	Dust	0			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continously Literature: Miljörapport 1996, Göteborg Energi AB	Output	Emission	NOx	0.212			g	Air	
Notes: Natural gas contains no sulphur.	Output	Emission	SO2	0			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose was to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden. The data for this system should only be used on plants in Sweden and for swedish conditions and regulations. When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.
Notes	Combined heat and power are used as base primarly during the winter half, when the need for heat and power are the largest.

SPINE LCI dataset: Natural gas, cradle-to-gate, unknown allocation - f3 fuels

Administrative

Finished	Y

Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System

Name	Natural gas, cradle-to-gate, unknown allocation - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of natural gas
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of natural gas. The following process are covered: - Production - Distribution The natural gas is assumed to come from 5 different sources. 52 % from Western Europe, 48 % import - mainly from Russia and Algeria. Medium transport length in Western Europe is 400 km. The transport from Russia and Algeria is a medium value of 690 km in tanks and 1000 km in pipeline. Distribution loss is 0,9 %, and about 0,15 % is flared off under production. 10 % of what is flared stays unburned. Total losses of natural gas about 11 g per kg delivered natural gas. According to the method document in the study, the averages are based on the weight if natural gas from different countries and sources. The study is conducted according to ISO 14040-44, international standards for life cycle assessment. The study agrees well with other studies and databases, but the emissions of nitrous oxide is lower in this study than in others (this does not however affect the results significantly). In general, there is a higher leakage from production and distribution of Russian natural gas, which impacts the total environmental impact if the natural gas mix strongly.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Western Europe
Other Boundaries	
Allocations	Unknown allocation when natural gas and oil are co-produced.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	The data for mounting profile has been approximated with the production of trapezium sheet steel.
Method	Literature studies
Literature Reference	(1) Bousted, Ian (2005). Eco-profiles of the European Plastics Industry – Natural gas, http://lca.plasticseurope.org/ngas3.htm. Production data are from IEA 2001 (2) Swedegas, http://www.swedegas.se/gasnatet/gaskvalitet/gaskvalitet_i_sverige. Here an Exce
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Resource	Crude oil	5.76461282247862E-03			MJ	Ground	
	Input	Resource	Ground water	9.63399612761422E-10			kg	Water	
	Input	Resource	Hard coal	1.95237038540308E-02			MJ	Ground	
	Input	Resource	Hydro power	3.56669916671004E-04			MJ	Ground	
	Input	Resource	Lignite	1.28813235450019E-09			MJ	Ground	
	Input	Resource	Natural gas	1.17540583855781			MJ	Ground	
	Input	Resource	Nuclear power	0.01379989914259			MJ	Ground	
	Input	Resource	River water	9.86823869425155E-09			kg	Water	
	Input	Resource	Sea water	9.34753470761784E-07			kg	Water	
	Input	Resource	Water (public supply)	3.66608711417782E-06			kg	Water	
	Input	Resource	Water (unspecified)	7.25971079086868E-04			kg	Water	
	Output	Emission	Acid (as H+)	4.89405897436964E-09			kg	Water	
	Output	Emission	Aldehyde	4.43781206326641E-18			kg	Air	
	Output	Emission	Ammonia	4.63092367868761E-13			kg	Air	
	Output	Emission	Ammonium	4.59458768126845E-09			kg	Water	
	Output	Emission	Aromatic hydrocarbons (unspecified)	4.15605006780529E-10			kg	Air	
	Output	Emission	Biological oxygen demand	3.72756686535134E-10			kg	Water	
	Output	Emission	Carbon dioxide (fossil)	5.0873310565539E-03			kg	Air	
	Output	Emission	Carbon monoxide	1.80555196822114E-05			kg	Air	
	Output	Emission	Chemical oxygen demand	4.64143706366102E-09			kg	Water	
	Output	Emission	Chlorine	6.35962344954525E-14			kg	Air	
	Output	Emission	Dissolved chlorine	8.17665243945902E-15			kg	Water	
	Output	Emission	Fluorine	1.2180184141817E-14			kg	Air	
	Output	Emission	Hydrocarbons (unspecified)	2.37701828513439E-06			kg	Air	
	Output	Emission	Hydrofluorcarbons (unspecified)	9.68728740132493E-15			kg	Air	
	Output	Emission	Hydrogen chloride	3.70912150050194E-07			kg	Air	
	Output	Emission	Hydrogen fluoride	1.39302053982589E-08			kg	Air	
	Output	Emission	Hydrogen sulfide	6.86430087722475E-12			kg	Air	
	Output	Emission	Mercaptan	2.66138219057879E-13			kg	Air	
	Output	Emission	Methane	2.52648950303668E-04			kg	Air	
	Output	Emission	Nitrate	3.73221117815037E-11			kg	Water	
	Output	Emission	Nitrogen	1.08763110825573E-09			kg	Water	
	Output	Emission	Nitrogen dioxide	1.16258748713955E-05			kg	Air	
	Output	Emission	Nitrous oxide	2.38204797383545E-15			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	7.30537909163517E-11			kg	Air	
	Output	Emission	Organics (unspecified)	4.10723185814706E-13			kg	Water	
	Output	Emission	Organics (unspecified)	4.69277785647535E-13			kg	Air	
	Output	Emission	Particles (PM10)	5.913369811765E-06			kg	Air	
	Output	Emission	Phosphorus	1.24094616467462E-11			kg	Water	
	Output	Emission	Polycyclic aromatic hydrocarbons	1.96172847165136E-42			kg	Air	
	Output	Emission	Sulfate	3.28754730759385E-11			kg	Water	
	Output	Emission	Sulfur	1.71451082685645E-15			kg	Water	
	Output	Emission	Sulfur dioxide	1.92252085200234E-05			kg	Air	
	Output	Emission	Sulfuric acid	1.66497510191325E-21			kg	Air	
	Output	Product	Natural gas	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL

Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Netherlands, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Netherlands, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Netherlands
Sector	Energyware
Owner	Netherlands
Technical system description	The generation of electricity with different power generating systems in the Netherlands during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	The data for mounting profile has been approximated with the production of trapezium sheet steel.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.

Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	106			GWh	Technosphere	
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	212			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	27274			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	3528			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	3605			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	3814			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	5			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	51981			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	640			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	91165			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998

	Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: New Zealand, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	New Zealand, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	New Zealand
Sector	Energyware
Owner	New Zealand
Technical system description	The generation of electricity with different power generating systems in New Zealand during the year 1998.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	The data for mounting profile has been approximated with the production of trapezium sheet steel.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	1463			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	24365			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	2478			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	509			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	51			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	8700			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	37566			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.

Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: N-fertilizer production

Administrative	
Finished	Y
Date Completed	1996-11-14

Copyright	
Availability	Public

Technical System	
Name	N-fertilizer production
Functional Unit	kg N
Functional Unit Explanation	Per kg N-fertilizer
Process Type	Gate to gate
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	Industrial production of N-fertilizer via steam reforming/partial oxidation of fossil fuels and ammonia synthesis through the Haber-Bosch process.

System Boundaries	
Nature Boundary	Emissions to air and water
Time Boundary	Data from 1987-1995
Geographical Boundary	Production site in Germany
Other Boundaries	N/A
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1996-11-14
Data Type	Unspecified
Represents	The data for mounting profile has been approximated with the production of trapezium sheet steel.
Method	These data are weighted averages for different N-fertilizers and are accumulated including ammonia synthesis from fossil fuels, salpete acid production and urea production. Rawmaterials (fuel oil, natural gas, coal and electricity) are registred as energy demands in MJ, and must be connected with the proper energy carrier production activity. Energy for transports is not included.
Literature Reference	A-M Tillman et al. Use of agro fibre for paper production from an environmental point of view, Nordpap DP 2/54, Scan forskrapport 682, oktober 1997. Original sources (presentations at VITO conference): 1. Andreas Patyk, IFEU 2. Böckman et al.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Coal	3.95			MJ	Technosphere	Germany
	Input	Refined resource	Electricity	0.13			MJ	Technosphere	Germany
	Input	Refined resource	Fuel oil	4.38			MJ	Technosphere	Germany
	Input	Refined resource	Natural gas	33			MJ	Technosphere	Germany
	Output	Emission	CH4	0.00045			kg	Air	Germany
	Output	Emission	CO	0.00215			kg	Air	Germany
	Output	Emission	CO2	2.404			kg	Air	Germany
	Output	Emission	Dust	0.0007			kg	Air	Germany
	Output	Emission	Formaldehyde	0.0000034			kg	Air	Germany
	Output	Emission	HCl	0.00011			kg	Air	Germany
	Output	Emission	N2O	0.01749			kg	Air	Germany
	Output	Emission	NH3	0.011			kg	Air	Germany
	Output	Emission	NH4-N	0.00321			kg	Water	Germany

	Output	Emission	NMHC	0.00011			kg	Air	Germany
	Output	Emission	NO3-N	0.001107			kg	Water	Germany
	Output	Emission	NOx	0.01547			kg	Air	Germany
	Output	Emission	SO2	0.0033			kg	Air	Germany
	Output	Product	Nitrogen fertiliser	1			kg	Technosphere	Germany

About Inventory	
Publication	A-M Tillman et al. Use of agro fibre for paper production from an environmental point of view, Nordpap DP 2/54, Scan forskrapport 682, oktober 1997. Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology
Intended User	LAC practitioners
General Purpose	N-fertilizer is an important ancilliary material in silvicultural operations.
Detailed Purpose	N/A
Commissioner	
Practitioner	Backlund, Birgit - STFI Box 5604 S-114 86 Stockholm .
Reviewer	
Applicability	N/A
About Data	N/A
Notes	N/A

SPINE LCI dataset: Night vision camera assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera assembly. Autoliv ESA-DBP
Functional Unit	1 unit of night vision camera
Functional Unit Explanation	The night vision camera weighs 375 grams
Process Type	Unit operation
Site	Autoliv Goleta. California, United States.
Sector	Manufacturing
Owner	Autoliv Goleta. California, United States.
Technical system description	The studied night vision camera is produced by Autoliv and mounted in BMW and Audi. It is based on far-infrared technology. The device is sensitive to the infrated energy from the warm objects and living beings, which can be seen on the screen by the driver allowing him/her to see in total darkness. The driver can see even 3 times further than the ordinary headlight range. The night vision camera is assembled in Autoliv in Goleta, US. The assembly is done partially manually and with the usage of the special equipment. It weighs 375 grams and consists of few main parts: window retainer, window, lens heater, rubber seal, screws, front enclosure, gasket, lens assembly, shutter, sensor retainer, sensor, heat sink, EMI gasket, video printed circuit board, power printed circuit board, rear enclosure, label and rear

	flange. This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication: - Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera's label manufacturing. Autoliv ESA-DBP - Night vision camera's lens assembly. Autoliv ESA-DBP - Night vision camera's shutter manufacturing. Autoliv ESA-DBP - Night vision camera's spring extension. Autoliv ESA-DBP - Night vision camera's motor manufacturing. Autoliv ESA-DBP - Night vision camera's lens heater manufacturing. Autoliv ESA-DBP - Night vision camera's thermistor manufacturing. Autoliv ESA-DBP - Night vision camera's gasket manufacturing. Autoliv ESA-DBP - Night vision camera's screw manufacturing. Autoliv ESA-DBP - Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is a unit operation. It relates only to the assembly process of 21 subcomponents. Data given by Autoliv in Goleta, US show the emissions to air and also the waste are produced.
Time Boundary	The data were acquired in 2010 and they come from 2008 and 2009.
Geographical Boundary	The manufacturing plant is located in Goleta, US.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''From feasibility point of view capital goods production and transport, other aspects of environmental related to personnel will not be included in the study. Study does not handle issues related to working environment.''
Allocations	The allocation procedure was applicable in case of electricity, He and CO2. Those values were given for the annual production. Allocation was based on the number of products that were produced.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	In the database there are inventory data for more components from this product.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: The product weighs 1 gram	Input	Input Product	EMI gasket	1			pce	Technosphere	United States
	Input	Input Product	Flange	1			pce	Technosphere	United States
	Input	Input Product	Front enclosure	1			pce	Technosphere	United States
Notes: The product weighs 1 gram	Input	Input Product	Gasket	1			pce	Technosphere	United States
Notes: The product weighs 0.3 gram	Input	Input Product	Heat sink	1			pce	Technosphere	United States
Notes: The product weighs 0.5 gram	Input	Input Product	Label	1			pce	Technosphere	United States
Notes: The product weighs 46 grams	Input	Input Product	Lens assembly	1			pce	Technosphere	United States
	Input	Input Product	Lens heater	1			pce	Technosphere	United States

	Input	Input Product	Packaging material ESD foam	1			pce	Technosphere	United States
Notes: The product weighs 35 grams	Input	Input Product	Power printed circuit board	1			pce	Technosphere	United States
Notes: The product weighs 107 grams	Input	Input Product	Rear enclosure	1			pce	Technosphere	United States
Notes: The product weighs 1g.	Input	Input Product	Rubber seal/gasket	1			pce	Technosphere	United States
Notes: The product weighs 0.21 gram	Input	Input Product	Screw	9			pce	Technosphere	United States
Notes: The product weighs 8.4 grams	Input	Input Product	Sensor	1			pce	Technosphere	United States
Notes: The product weighs 1.3 gram	Input	Input Product	Sensor retainer	1			pce	Technosphere	United States
Notes: The product weighs 5 grams	Input	Input Product	Shutter	1			pce	Technosphere	United States
	Input	Input Product	Software	1			pce	Technosphere	United States
Notes: The product weighs 19 grams	Input	Input Product	Video printed circuit board	1			pce	Technosphere	United States
Notes: The product weighs 19.9 grams	Input	Input Product	Window	1			pce	Technosphere	United States
Notes: The product weighs 10.3 grams	Input	Input Product	Window retainer	1			pce	Technosphere	United States
	Input	Refined resource	Electricity	1.28+00			MJ	Technosphere	United States
	Input	Refined resource	He	2.62E-01			l	Technosphere	United States
Notes: in the source data the data are given with unit ''ribbon per camera''	Input	Refined resource	Thermal transfer printers	1.78E-03			pce	Technosphere	United States
	Output	Emission	CO2	3.24E+00			l	Technosphere	United States
Notes: The finished product is transported to Germany to be installed in Audi and BMW	Output	Product	Camera	1			pce	Technosphere	United States
Notes: According to Stena Recycling 99% of metal parts should be recycled	Output	Residue	Aluminium	3.70E-03			kg	Technosphere	United States
Notes: According to Stena, 99% of metal parts should be recycled	Output	Residue	Electronic parts	3.70E-04			kg	Technosphere	United States
Notes: Germanium is landfilled	Output	Residue	Germanium	7.41E-04			kg	Technosphere	United States

About Inventory	
Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed night vision camera was the object of the study. The main goals of the study are: (excerpt from the report, see 'Literature reference') ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above

About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The product is quite new on the market. The first version appeared in 2005 and from 2008 2nd model of night vision camera is available. At the end of its life, night vision camera as a part of the car is shredded together with it. According to Stena Metal AB 99% of metal parts is recycled. Plastic parts are recovered as an energy. Not all the parts can be recovered. The window for example, which consists of germanium, is landfilled. The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera's gasket manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera's gasket manufacturing. Autoliv ESA-DBP
Functional Unit	1 gasket
Functional Unit Explanation	1 gasket weighs 1 gram. There are three different parts in a night vision camera. The night vision camera weighs 375 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A gasket is used ussually to fill the space between two or more objects in order to for example keep the gas or liquid pressure or insulating the object from the air, moisture or other liquids. There are few gaskets in the night vision camera: by front enclosure, rear enclosure and window. The content, weight, production processes and manufacturer are the same for all of them. They are made of rubber EPDM (ethylene propylene diene monomer) and carbon black. The weight is 1 gram. They are manufactured in Chicago, US. The production process consists of the following steps: 1. Heating and moulding the rubber 2. Adding the silicon as a inner core material 3. Adding carbon black This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication:

	- Night vision camera assembly. Autoliv ESA-DBP - Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera's label manufacturing. Autoliv ESA-DBP - Night vision camera's lens assembly. Autoliv ESA-DBP - Night vision camera's shutter assembly. Autoliv ESA-DBP - Night vision camera's spring extension. Autoliv ESA-DBP - Night vision camera's motor manufacturing. Autoliv ESA-DBP - Night vision camera's lens heater manufacturing. Autoliv ESA-DBP - Night vision camera's thermistor manufacturing. Autoliv ESA-DBP - Night vision camera's screw manufacturing. Autoliv ESA-DBP - Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with processing the materials from the suppliers and ends with adding carbon black. Data given by gasket manufacturer do not show any emissions.
Time Boundary	The data were acquired in 2009.
Geographical Boundary	The manufacturer is placed in Chicago in Illinois, US.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The data were given per month. The allocation was done based on the number of produced products.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	NB: in inventory data no information about silicon or waste water

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Data importer notes: Value reliability questioned. Value is reported in the reference.	Input	Natural resource	Water	5.86E+00			l	Water	United States
	Input	Refined resource	Carbon black	1.08E-03			kg	Technosphere	United States
	Input	Refined resource	Electricity	9.74E-02			MJ	Technosphere	United States
	Input	Refined resource	Ethylene propylene diene monomer (EPDM)	1.71E-03			kg	Technosphere	United States
	Output	Product	Gasket	1			pce	Technosphere	United States

About Inventory

Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.

Detailed Purpose	The discussed gasket is a part of the night vision camera which was the object of the study. The main goals of the study are (excerpt from the report, see 'Literature reference'): ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera's label manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera's label manufacturing. Autoliv ESA-DBP
Functional Unit	1 label
Functional Unit Explanation	1 label weighs 0.5 gram and it is a part of night vision camera which weighs 375 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The label has an informing function. The studied one is manufactured in Strongsville in Ohio, US. The label is blank and it is processed later in Autoliv. The label consists of silicon coated paper, adhesive and a film which is made from PET (Polyethylene terephthalate) and it weighs 0.5 gram. The materials are produced 100 miles from the plant in Strongsville.

	Manufacturing process of label consists of the following steps: 1. Applying adhesive into 1 side of PET film. 2. Laying the liner on the other side This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication: - Night vision camera assembly. Autoliv ESA-DBP - Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera's lens assembly. Autoliv ESA-DBP - Night vision camera's shutter manufacturing. Autoliv ESA-DBP - Night vision camera's spring extension. Autoliv ESA-DBP - Night vision camera's motor manufacturing. Autoliv ESA-DBP - Night vision camera's lens heater manufacturing. Autoliv ESA-DBP - Night vision camera's thermistor manufacturing. Autoliv ESA-DBP - Night vision camera's gasket manufacturing. Autoliv ESA-DBP - Night vision camera's screw manufacturing. Autoliv ESA-DBP - Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. The process consists of applying different layers on the label. Data given by label manufacturer show only air emissions.
Time Boundary	The data were acquired in 2009.
Geographical Boundary	The manufacturer is located in Strongsville in Ohio, US
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The data were given by manufacturer per 1 unit of label.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	NB: in inventory data no information about silicon or waste water

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Adhesive	1.40E-04			kg	Technosphere	Ohio
	Input	Refined resource	Electricity	8.00E-04			MJ	Technosphere	Ohio
	Input	Refined resource	Film	1.40E-04			kg	Technosphere	Ohio
	Input	Refined resource	Liner	8.10E-04			kg	Technosphere	Ohio
	Output	Emission	hazardous air pollutants	3.55E-03			kg	Air	United States
	Output	Emission	VOC	2.41E-02			kg	Air	United States
Notes: Label weighs 0.5 gram	Output	Product	Label	1			pce	Technosphere	Ohio

About Inventory

Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed label is a part of the night vision camera which was the object of the study. The main goals of the study are (excerpt from the report, see 'Literature reference'): ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of the metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera's lens assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera's lens assembly. Autoliv ESA-DBP
Functional Unit	1 lens assembly
Functional Unit Explanation	1 lens assembly weighs 4.6 grams and it is a part of the night vision camera which weighs 375 grams.

Process Type	Unit operation
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Lenses in the cameras are ussualy made of one or few layers of transparent material (can be glass, plastics, gel etc.). The basic function of them is focusing or diffusing the light in order to achieve a better picture. (Wikipedia, 2010). In case of night vision camera there are two different layers: germanium and zinc-selenium. Except those in the lens assembly there are many other parts like: housing, spacer, lens cell, flange, retaining ring, sleeve cast, retaining nut, bushing, wave spring, wave spring washer, self lock, bushing 7.8 mm and bushing 8.9 mm. In total it weighs 4.6 grams. This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication: - Night vision camera assembly. Autoliv ESA-DBP - Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera's label manufacturing. Autoliv ESA-DBP - Night vision camera's shutter manufacturing. Autoliv ESA-DBP - Night vision camera's spring extension. Autoliv ESA-DBP - Night vision camera's motor manufacturing. Autoliv ESA-DBP - Night vision camera's lens heater manufacturing. Autoliv ESA-DBP - Night vision camera's thermistor manufacturing. Autoliv ESA-DBP - Night vision camera's gasket manufacturing. Autoliv ESA-DBP - Night vision camera's screw manufacturing. Autoliv ESA-DBP - Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP NB: Reference: http://en.wikipedia.org/wiki/Lens_(optics)

System Boundaries

Nature Boundary	The performed study is a unit operation. It relates to the assembly process of the lens. Data given by lens manufacturer show air emissions. Liquid and solid waste is produced.
Time Boundary	The data were acquired in 2009 and 2010.
Geographical Boundary	The lens manufacturer is located in North Andover in Massachusetts, US.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Allocation for electricity, waste and emissions was done based on monthly values of these items and annual production. The values were calculated for 1 year and divided in a number of produced lenses.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	NB: in inventory data no information about silicon or waste water

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Input Product	Blank germanium	4.20E-03			kg	Technosphere	United States
	Input	Input Product	Blank zinc-selenium	3.30E-03			kg	Technosphere	United States

Notes: The product weighs 0.00148 kg	Input	Input Product	Bushing	1			pce	Technosphere	United States
Notes: The product weighs 0.00072 kg	Input	Input Product	Bushing 7.8 mm	1			pce	Technosphere	United States
Notes: The product weighs 0.00055 kg	Input	Input Product	Bushing 8.9 mm	1			pce	Technosphere	United States
Notes: The product weighs 0.00046 kg	Input	Input Product	Flange	1			pce	Technosphere	United States
Notes: The product weighs 0.00345 kg	Input	Input Product	Housing	1			pce	Technosphere	United States
Notes: The product weighs 0.00261 kg	Input	Input Product	Lens cell	1			pce	Technosphere	United States
Notes: The product weighs 0.00246 kg.	Input	Input Product	Retaining nut	1			pce	Technosphere	United States
Notes: The product weighs 0.00036 kg	Input	Input Product	Retaining ring	1			pce	Technosphere	United States
	Input	Input Product	Self lock	1			pce	Technosphere	United States
Notes: The weight of the product is 0.026 gram	Input	Input Product	Sleeve cast	1			pce	Technosphere	United States
Notes: The product weighs 0.0009 kg	Input	Input Product	Spacer	1			pce	Technosphere	United States
Notes: The product weighs 0.00013 kg	Input	Input Product	Wave spring	1			pce	Technosphere	United States
Notes: The product weighs 0.00037 kg	Input	Input Product	Wave spring washer	1			pce	Technosphere	United States
	Input	Refined resource	Adhesive	5.00E-05			kg	Technosphere	United States
	Input	Refined resource	Electricity	1.46E-01			MJ	Technosphere	United States
	Output	Emission	Particles	8.05E-04			kg	Air	United States
	Output	Product	Lens assembly	1			pce	Technosphere	United States
Notes: Data importer notes: no information about waste treatment. The liquid hazardous waste is water with trace amounts of zinc selenide	Output	Residue	Liquid hazardous waste	2.80E-03			kg	Technosphere	United States
Notes: Data importer notes: no information about waste treatment. The liquid non hazardous waste is water with germanium	Output	Residue	Liquid non-hazardous waste	6.26E-03			l	Technosphere	United States
Notes: Data importer notes: no information about waste treatment. Soild waste is mainly slurry with zinc selenide.	Output	Residue	Solid hazardous waste	1.47E-03			kg	Technosphere	United States

About Inventory	
Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed lens assembly is a part of the night vision camera which was the object of the study. The main goals of the study are (excerpt from the report, see 'Literature reference'): ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -

Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera's lens heater manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera's lens heater manufacturing. Autoliv ESA-DBP
Functional Unit	1 lens heater
Functional Unit Explanation	1 lens heater weighs 0.2 gram while the whole night vision camera weighs 375 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The lens heater is a part which has a function of eliminating the moisture from inner part of the camera especially on the surface of the lens. The heater is manufactured in Kolbäck, Sweden. It consists of copper nickel foil, polyamide 66, adhesive, poron and thermistor and weighs 0.2 gram. The production process consists of the following steps: 1. Creating a metal circuit using CuNi foil 2. Laminating with thick polyamide film 3. Printing the pattern circuit on metal side with UV cured paint 4. Etching with iron chloride the non covered areas 5. Putting the top lamination 5. Soldering the thermistor 6. Adding the poron layer 7. Shaping 8. Control This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication:

	- Night vision camera assembly. Autoliv ESA-DBP - Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera's label manufacturing. Autoliv ESA-DBP - Night vision camera's lens assembly. Autoliv ESA-DBP - Night vision camera's shutter assembly. Autoliv ESA-DBP - Night vision camera's spring extension. Autoliv ESA-DBP - Night vision camera's motor manufacturing. Autoliv ESA-DBP - Night vision camera's thermistor manufacturing. Autoliv ESA-DBP - Night vision camera's gasket manufacturing. Autoliv ESA-DBP - Night vision camera's screw manufacturing. Autoliv ESA-DBP - Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with creating the metal circuit and ends with control. Data given by lend heater manufacturer show only air emissions.
Time Boundary	The data were acquired in 2009.
Geographical Boundary	The manufacturer is located in Kolbäck, Sweden.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The data were given per 1 product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	NB: in inventory data no information about silicon or waste water

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Input Product	Adhesive	5.63E-05			kg	Technosphere	Sweden
Notes: The product weighs 4.70E-06 kg	Input	Input Product	Thermistor	1			pce	Technosphere	Sweden
	Input	Natural resource	Water	4.00E-01			l	Technosphere	Sweden
	Input	Refined resource	CuNi	1.00E-05			kg	Technosphere	Sweden
	Input	Refined resource	Electricity	4.68E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Polyamide 66 (PA66)	1.30E-04			kg	Technosphere	Sweden
	Input	Refined resource	Poron	9.00E-06			kg	Technosphere	Sweden
	Output	Emission	VOC	1.20E-10			kg	Technosphere	Sweden
Notes: the product weighs 0.2 gram	Output	Product	Lens heater	1			pce	Technosphere	Sweden

About Inventory

Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner

General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed lens heater is a part of the night vision camera which was the object of the study. The main goals of the study are (excerpt from the report, see 'Literature reference'): ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera's motor manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera's motor manufacturing. Autoliv ESA-DBP
Functional Unit	1 motor
Functional Unit Explanation	1 motor weighs 2.8 grams while the whole night vision camera weighs 375 grams.
Process Type	Unit operation
Site	Unknown
Sector	Manufacturing
Owner	Unknown

Technical system description	Motor is a part of a shutter in the night vision camera. It is produced in Hongkong. It consists of the folloing parts: washer, shaft, core, insulating material, commutator core, commutator, commutator washer, rotor bush, varistor, solder, magnet wire, plastic magnet, housing, bearing, terminal, brush, bearing, endbell, adhesive and grease. In general the studied motor consists of 50 % of steel, 25% of copper and 25% of polymer. The total weight of motor is 2.8 grams. This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication: - Night vision camera assembly. Autoliv ESA-DBP - Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera's label manufacturing. Autoliv ESA-DBP - Night vision camera's lens assembly. Autoliv ESA-DBP - Night vision camera's shutter assembly. Autoliv ESA-DBP - Night vision camera's spring extension. Autoliv ESA-DBP - Night vision camera's lens heater manufacturing. Autoliv ESA-DBP - Night vision camera's thermistor manufacturing. Autoliv ESA-DBP - Night vision camera's gasket manufacturing. Autoliv ESA-DBP - Night vision camera's screw manufacturing. Autoliv ESA-DBP - Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is a unit operation. It relates to the assembly process of the components. Data given by motor manufacturer show waste and air emissions.
Time Boundary	The data were acquired in 2009.
Geographical Boundary	The manufacturing plant is located in Hong Kong.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The data were given per 1 motor by the manufacturer.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	NB: The manufacturing process was not traced to the cradle, so the details (such as weight, content etc.) about the subcomponents are not known. Excerpt from the report: '' because of lack of time and wt. of this motor (approx. 3 g) it is not possible to see each component upto cradle thus to make calculations simpler only 3 major materials are studied to cradle. It is seen from IMDS that motor is composed approx. of 50 % steel, 25% Cu and 25% polymer.''

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Data importer notes: Value reliability questioned. Value as reported in the reference.	Input	Input Product	Adhesive	1.00E-03			g	Technosphere	Hong Kong
	Input	Input Product	Bearing 1	1			pce	Technosphere	Hong Kong
	Input	Input Product	Bearing 2	1			pce	Technosphere	Hong Kong
	Input	Input Product	Brush	1			pce	Technosphere	Hong Kong
	Input	Input Product	Commutator	1			pce	Technosphere	Hong Kong

	Input	Input Product	Commutator core	1			pce	Technosphere	Hong Kong
	Input	Input Product	Commutator washer	1			pce	Technosphere	Hong Kong
	Input	Input Product	Core	2			pce	Technosphere	Hong Kong
	Input	Input Product	End cap	1			pce	Technosphere	Hong Kong
	Input	Input Product	Grease	1			pce	Technosphere	Hong Kong
	Input	Input Product	Housing	1			pce	Technosphere	Hong Kong
	Input	Input Product	Insulating material	1			pce	Technosphere	Hong Kong
	Input	Input Product	Magnet wire	1			pce	Technosphere	Hong Kong
	Input	Input Product	Plastic magnet	1			pce	Technosphere	Hong Kong
	Input	Input Product	Rotor bush	1			pce	Technosphere	Hong Kong
	Input	Input Product	Shaft	1			pce	Technosphere	Hong Kong
	Input	Input Product	Solder	1			pce	Technosphere	Hong Kong
	Input	Input Product	Terminal	1			pce	Technosphere	Hong Kong
	Input	Input Product	Varistor	1			pce	Technosphere	Hong Kong
	Input	Input Product	Washer	3			pce	Technosphere	Hong Kong
	Input	Refined resource	Electricity	3.96E-02			MJ	Technosphere	Hong Kong
Notes: Data importer notes: Value reliability questioned. Value as reported in the reference.	Input	Refined resource	Oil	1.00E-03			g	Technosphere	Hong Kong
	Output	Emission	CO2	8.20E-02			kg	Air	Hong Kong
Notes: The product weighs 0.0028 kg	Output	Product	Motor	1			pce	Technosphere	Hong Kong
	Output	Residue	Waste	2.70E-02			kg	Technosphere	Hong Kong

About Inventory	
Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed motor is a part of the night vision camera which was the object of the study. The main goals of the study are (excerpt from the report, see 'Literature reference'): ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA).

	Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera’s rear enclosure manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera’s rear enclosure manufacturing. Autoliv ESA-DBP
Functional Unit	1 unit of rear enclosure
Functional Unit Explanation	1 rear enclosure weighs 107 grams and it is a part of night vision camera which weighs 375 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A rear enclosure part has a housing function for the camera. It is located on the back side of the it and is responsible for keeping the rear parts together. It is made of alluminium alloy and weighs 107 grams. The rear enclosure is produced in the plant in Lake Forest City in California. The manufacturing process consists of the following steps: 1. Dye casting 2. Removing the debris 3. Finishing on CNC machine This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv’s night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication: - Night vision camera assembly. Autoliv ESA-DBP - Night vision camera’s label manufacturing. Autoliv ESA-DBP - Night vision camera’s lens assembly. Autoliv ESA-DBP - Night vision camera’s shutter manufacturing. Autoliv ESA-DBP - Night vision camera’s spring extension. Autoliv ESA-DBP - Night vision camera’s motor manufacturing. Autoliv ESA-DBP - Night vision camera’s lens heater manufacturing. Autoliv ESA-DBP - Night vision camera’s thermistor manufacturing. Autoliv ESA-DBP - Night vision camera’s gasket manufacturing. Autoliv ESA-DBP - Night vision camera’s screw manufacturing. Autoliv ESA-DBP - Night vision camera’s sensor retainer manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is gate-to-gate. It starts with casting and ends with finishing on CNC. Data given by rear enclosure manufacturer show only oil emission and scrap production.
Time Boundary	The data were acquired in 2009.
Geographical Boundary	The manufacturer is located in US.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The data for electricity, water and waste were given per month. The values were allocated based on the number of annual production.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData	
Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	NB: The manufacturing process was not traced to the cradle, so the details (such as weight, content etc.) about the subcomponents are not known. Excerpt from the report: '' because of lack of time and wt. of this motor (approx. 3 g) it is not possible to see each component upto cradle thus to make calculations simpler only 3 major materials are studied to cradle. It is seen from IMDS that motor is composed approx. of 50 % steel, 25% Cu and 25% polymer.''

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Water	3.5E-01			kg	Water	United States
	Input	Refined resource	Aluminium alloy	2.57E-01			kg	Technosphere	United States
	Input	Refined resource	Electricity	1.57E+00			MJ	Technosphere	United States
Notes: The weight of the product is 107 grams.	Output	Product	Rear enclosure	1			pce	Technosphere	United States
Notes: Data importer notes: no information in the report about the destiny of oil, value reliability questioned. Value as reported in the reference.	Output	Residue	Alu/zinc oil	1.65E+00			kg	Technosphere	United States
Notes: To be recycled	Output	Residue	Aluminium scrap	1.50E-01			kg	Technosphere	United States

About Inventory	
Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed rear enclosure is a part of the night vision camera which was the object of the study. The main goals of the study are: (excerpt from the report, see 'Literature reference') ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental

	reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera's screw manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera's screw manufacturing. Autoliv ESA-DBP
Functional Unit	1 screw
Functional Unit Explanation	1 screw weighs 0.213 gram and is the part of night vision camera which weighs 375 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	A screw is ussually used for fastening the parts. There might be different sizes, materials and other parameters. The studied screw is 2.8 mm snap head bright tin plated and it is made of CuZn37 alloy and electroplated with tin and copper. 1 screw weighs 0.213 gram. There are 9 screws in night vision camera and they are manufactured in Warrington, UK. The finished products are transported to Autoliv Goleta in US. The manufacturing process consists of the following steps: 1. Creating the headed rivet 2. Degreasing 3. Forming the thread 4. Degreasing 5. Heat treatment

	6. Plating 7. Inspection 8. Packaging This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication: - Night vision camera assembly. Autoliv ESA-DBP - Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera's label manufacturing. Autoliv ESA-DBP - Night vision camera's lens assembly. Autoliv ESA-DBP - Night vision camera's shutter assembly. Autoliv ESA-DBP - Night vision camera's spring extension. Autoliv ESA-DBP - Night vision camera's motor manufacturing. Autoliv ESA-DBP - Night vision camera's lens heater manufacturing. Autoliv ESA-DBP - Night vision camera's thermistor manufacturing. Autoliv ESA-DBP - Night vision camera's gasket manufacturing. Autoliv ESA-DBP - Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with creating the headed rivet and ends with inspection and packaging. Data given by screw manufacturer do not show any emissions.
Time Boundary	Data were acquired in 2009.
Geographical Boundary	The manufacturer is located in Warrington, UK.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Data were given per 1 screw.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	There are 9 screws in 1 night vision camera

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	CuZn37	2.07E-01			g	Technosphere	United Kingdom
	Input	Refined resource	Electricity	2.25E-03			MJ	Technosphere	United Kingdom
	Input	Refined resource	E-plate copper	1.50E-03			g	Technosphere	United Kingdom
	Input	Refined resource	E-plate tin	4.89E-03			g	Technosphere	United Kingdom
	Output	Product	Screw	1			pce	Technosphere	United Kingdom
	Output	Residue	Solid waste	2.60E-05			g	Technosphere	United Kingdom

About Inventory

Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner

General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed screw is a part of the night vision camera which was the object of the study. The main goals of the study are (excerpt from the report, see 'Literature reference'): ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP
Functional Unit	1 sensor retainer
Functional Unit Explanation	1 sensor retainer weighs 9.5 grams and is a part of the night vision camera which weighs 375 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown

Technical system description	The studied sensor retainer is used for stabilizing the sensor in the night vision camera. It has a shape of square and is made of polyamide 6.6, glass fibre, lubricants and stabilizers. The product is manufactured in Chicago, US and the process consists heating and moulding polyamide 66 which is followed by adding the lubricants, dying stuff, stabilizers and fibre glass. It weighs 9.5 grams. This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication: - Night vision camera assembly. Autoliv ESA-DBP - Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera's label manufacturing. Autoliv ESA-DBP - Night vision camera's lens assembly. Autoliv ESA-DBP - Night vision camera's shutter assembly. Autoliv ESA-DBP - Night vision camera's spring extension. Autoliv ESA-DBP - Night vision camera's motor manufacturing. Autoliv ESA-DBP - Night vision camera's lens heater manufacturing. Autoliv ESA-DBP - Night vision camera's thermistor manufacturing. Autoliv ESA-DBP - Night vision camera's gasket manufacturing. Autoliv ESA-DBP - Night vision camera's screw manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with heating and moulding and ends with adding glass fibre and additives. Data given by sensor retainer manufacturer do not show any emissions.
Time Boundary	Data were acquired in 2009.
Geographical Boundary	The manufacturer is located in Chicago, Illinois, US
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The data for electricity and water were given per monthly production. The allocation was based on the number of manufactured products.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--7.pdf
Notes	NB: in the report no information about dying stuff and stabilizers

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Water	7.46E-01			l	Water	United States
	Input	Refined resource	Electricity	4.46E-02			MJ	Technosphere	United States
	Input	Refined resource	Glass fibre	3.33E-03			kg	Technosphere	United States
	Input	Refined resource	Polyamide 66 (PA66)	5.70E-03			kg	Technosphere	United States
Notes: The product weighs 9.5 grams.	Output	Product	Sensor retainer	9.50E-03			kg	Technosphere	United States

About Inventory

Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed sensor retainer is a part of the night vision camera which was the object of the study. The main goals of the study are (excerpt from the report, see 'Literature reference'): ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera's shutter assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera's shutter assembly. Autoliv ESA-DBP
Functional Unit	1 shutter
Functional Unit Explanation	1 shutter weighs 5.15 grams and it is a part of the night vision camera which weighs 375 grams.

Process Type	Unit operation
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	In general a shutter is a component of a camera which is opened and closed in order to allow the light to pass through the lens to the light sensitive electronic sensor. (Wikipedia, 2010). In the night vision camera it allows to register and view clear image even of the fast moving objects. (Media College, 2010) The studied shutter is produced in a plant in Mexico and then transported to Autoliv Goleta in US. It consists of few components: paddle, spring, spring clip, pinion gear, face gear, gearbox cover, harness, and motor. Most of the components is assembled using the adhesive. The weight of the shutter is 5.15 grams. This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication: - Night vision camera assembly. Autoliv ESA-DBP - Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera's label manufacturing. Autoliv ESA-DBP - Night vision camera's lens assembly. Autoliv ESA-DBP - Night vision camera's spring extension. Autoliv ESA-DBP - Night vision camera's motor manufacturing. Autoliv ESA-DBP - Night vision camera's lens heater manufacturing. Autoliv ESA-DBP - Night vision camera's thermistor manufacturing. Autoliv ESA-DBP - Night vision camera's gasket manufacturing. Autoliv ESA-DBP - Night vision camera's screw manufacturing. Autoliv ESA-DBP - Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP NB: Reference: Media College, 2010 (online) Available at: http://www.mediacollege.com/video/camera/shutter/ [accessed 30.06.2010] Wikipedia.2010 (online) Available at: http://en.wikipedia.org/wiki/Shutter_(photography) [accessed 30.06.2010]

System Boundaries

Nature Boundary	The performed study is a unit operation. It relates to the assembly process of shutter. Data given by the shutter manufacturer show only air emissions and waste production.
Time Boundary	Data were acquired in 2009.
Geographical Boundary	The shutter manufacturer is located in Mexico.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Most of the data was given per month except suspended solids and VOC which were given my year. The allocation was based on the annual and monthly number of produced items.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	NB: in the report no information about dying stuff and stabilizers

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***

Notes: The weight of the product is 1.22E-04 kg	Input	Input Product	Face gear	1			pce	Technosphere	Mexico
Notes: The weight of the product is 1.32E-03 kg	Input	Input Product	Gearbox	1			pce	Technosphere	Mexico
Notes: The weight of the product is 2.22 E-04 kg	Input	Input Product	Gearbox cover	1			pce	Technosphere	Mexico
Notes: The weight of the product is 1.97E-04 kg	Input	Input Product	Harness	1			pce	Technosphere	Mexico
Notes: The weight of the product is 2.8E-03 kg	Input	Input Product	Motor	1			pce	Technosphere	Mexico
Notes: The weight of the product is 1.77E-04 kg	Input	Input Product	Paddle	1			pce	Technosphere	Mexico
Notes: The weight of the product is 5.11E-5 kg	Input	Input Product	Pinion gear	1			pce	Technosphere	Mexico
Notes: The weight of the product is 7.3E-05 kg	Input	Input Product	Spring	1			pce	Technosphere	Mexico
Notes: The weight of the product is 3.19E-05 kg	Input	Input Product	Spring clip	1			pce	Technosphere	Mexico
	Input	Natural resource	Water	4.80E-01			kg	Water	Mexico
	Input	Refined resource	Adhesive	1.50E-05			kg	Technosphere	Mexico
	Input	Refined resource	Electricity	6.00E-01			MJ	Technosphere	Mexico
	Input	Refined resource	Gas	2.49E-04			m3	Technosphere	Mexico
	Output	Emission	Susp solids	5.29E-10			kg	Air	Mexico
	Output	Emission	VOC	4.76E-06			kg	Air	Mexico
Notes: The weight of the product is 5.15E-03 kg	Output	Product	Shutter	1			pce	Technosphere	Mexico
	Output	Residue	Cartboard boxes	4.80E-04			kg	Technosphere	Mexico
	Output	Residue	Oil and water emulsion	1.44E-03			kg	Technosphere	Mexico
Notes: to be recycled	Output	Residue	Solder residues	5.47E-04			kg	Technosphere	Mexico
	Output	Residue	Water with paint	1.10E-03			kg	Technosphere	Mexico
	Output	Residue	Wooden pallets	2.40E-04			kg	Technosphere	Mexico

About Inventory

Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed shutter is a part of the night vision camera which was the object of the study. The main goals of the study are (excerpt from the report, see 'Literature reference'): ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-

	Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera’s spring extension. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera’s spring extension. Autoliv ESA-DBP
Functional Unit	1 spring
Functional Unit Explanation	1 spring weighs 0.073 gram
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Spring extension can be used in different constructions. Usually it is ended with two hooks in order to be attached. The spring extension in a night vision camera is a part of a shutter and it is produced in Connecticut, US. It is made of stainless steel and weighs 0.073 gram. This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv’s night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication: - Night vision camera assembly. Autoliv ESA-DBP - Night vision camera’s rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera’s label manufacturing. Autoliv ESA-DBP - Night vision camera’s lens assembly. Autoliv ESA-DBP - Night vision camera’s shutter assembly. Autoliv ESA-DBP - Night vision camera’s motor manufacturing. Autoliv ESA-DBP - Night vision camera’s lens heater manufacturing. Autoliv ESA-DBP - Night vision camera’s thermistor manufacturing. Autoliv ESA-DBP - Night vision camera’s gasket manufacturing. Autoliv ESA-DBP - Night vision camera’s screw manufacturing. Autoliv ESA-DBP - Night vision camera’s sensor retainer manufacturing. Autoliv ESA-DBP

System Boundaries	
Nature Boundary	The performed study is gate-to-gate. Data given by spring manufacturer do not show any emissions.
Time Boundary	The data were acquired in 2009.

Geographical Boundary	The manufacturer of the spring is located in Connecticut, US.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of electricity, gas and water consumption. Those values were given for the monthly production. Allocation was based on the number of produced products.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	NB: in the report no information about dying stuff and stabilizers

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Natural gas	2.85E-02			l	Technosphere	United States
	Input	Natural resource	Water	3.41E-02			kg	Technosphere	United States
	Input	Refined resource	Electricity	1.08E-01			MJ	Technosphere	United States
	Input	Refined resource	Stainless steel	7.30E-05			kg	Technosphere	United States
	Output	Product	Spring extension	1			pce	Technosphere	United States

About Inventory

Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed spring is a part of the night vision camera which was the object of the study. The main goals of the study are (excerpt from the report, see 'Literature reference'): ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above

About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Night vision camera's thermistor manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-15
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Night vision camera's thermistor manufacturing. Autoliv ESA-DBP
Functional Unit	1 thermistor
Functional Unit Explanation	1 thermistor weighs 0.0047 gram.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Thermistor is a type of resistor whose resistance depends on the temperature. It is widely used in the electronic devices. (Thermometrics, 2010) The studied thermistor is placed in a lens heater. It is made of metal and ceramic and it weighs 0.0047 gram. The manufacturer of it is located in Nagaokaky, Japan. The manufacturing process consists of the following steps: 1. Sheet making 2. Inner electrode printing 3. Sheet stacking 4. Stacked block cutting to make a green thermistor chip 5. Termination 6. Plating 7. Inspection This process is included in the system described in: Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf Other processes in the CPM Database also included in the above publication: - Night vision camera assembly. Autoliv ESA-DBP - Night vision camera's rear enclosure manufacturing. Autoliv ESA-DBP - Night vision camera's label manufacturing. Autoliv ESA-DBP - Night vision camera's lens assembly. Autoliv ESA-DBP

	- Night vision camera's shutter assembly. Autoliv ESA-DBP - Night vision camera's spring extension. Autoliv ESA-DBP - Night vision camera's motor manufacturing. Autoliv ESA-DBP - Night vision camera's lens heater manufacturing. Autoliv ESA-DBP - Night vision camera's gasket manufacturing. Autoliv ESA-DBP - Night vision camera's screw manufacturing. Autoliv ESA-DBP - Night vision camera's sensor retainer manufacturing. Autoliv ESA-DBP NB: Reference: Thermometrics, 2010 (online): Available at: http://www.thermometrics.com/htmldocs/whatis.htm [accessed 6.07.2010]

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with sheet making and it ends up with plating and inspection. Data given by thermistor manufacturer do not show any emissions.
Time Boundary	Data were acquired in 2009.
Geographical Boundary	The product is manufactured in Japan.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Data documentor notes: no information about allocation
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--7.pdf
Notes	NB: in the report no information about dying stuff and stabilizers

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	9.00E-03			l	Water	Japan
	Input	Refined resource	Ceramic	4.12E-03			g	Technosphere	Japan
	Input	Refined resource	Electricity	7.92E-04			MJ	Technosphere	Japan
Notes: NB: material was not specified in the report	Input	Refined resource	Metal	5.80E-04			g	Technosphere	Japan
Notes: The product weighs 0.0047 gram	Output	Product	Thermistor	1			pce	Technosphere	Japan

About Inventory

Publication	Kuvalekar S., Hussain M. (2010). Life cycle assessment of Autoliv's night vision camera. Master thesis report. ESA report 2010:7, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--7.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed thermistor is a part of the night vision camera which was the object of the study. The main goals of the study are (excerpt from the report, see 'Literature reference'): ''1. What are the environmental impacts associated with a night vision camera? 2. What is the amount of waste, energy, water and emissions involved in the whole life cycle

	of the night vision camera? 3. Are there any materials that need to be replaced in the camera for environmental reasons? 4. To investigate for environmental reasons what would happen in the future if the electronic material is increased in the car?''
Commissioner	Autoliv Development AB - .
Practitioner	Shweta Kuvalekar & Munnwer Hussain - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the camera is dismantled by the personnel in recycling company and 95% of metal parts are recycled. The rest is landfilled. In case of plastics 5% is incinerated, 10% goes to the landfill and the rest is recycled (apart from germanium which is landfilled). The studied product is a part of the night vision camera which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the night vision camera, 3 other LCA studies for Autoliv were carried out (for airbag, seatbelt and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Norway, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Norway, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Norway
Sector	Energyware
Owner	Norway
Technical system description	The generation of electricity with different power generating systems in Norway during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.

Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	115359			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	192			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	222			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	296			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	7			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	7			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	116083			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.

Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Nuclear electricity energy system, EPD-version

Administrative	
Finished	Y
Date Completed	1996-10

Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Nuclear electricity energy system, EPD-version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures are based on data from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996 and adapted to the demands of the EPD-guidelines (Environmental Product Declaration guidelines in Sweden). -- Brief description -- The phases inventoried in ETH's life cycle study of nuclear power are: uranium mine, uranium ore processing, conversion, enrichment, fuel fabrication, nuclear power plant, reprocessing of spent fuel, interim and final storages for conditioned low, medium and high level radioactive waste. Data has been aquired from literature and figures concerning consumption of energyware and materials, use of land and water, emissions (radioactive and non-radioactive to air and water) and wastes have been picked out from or calculated based on literature and official reports from authorities where available for all phases of the life cycle. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle. -- Detailed description -- Uranium mine Underground and open pit mining has been studied including extraction work, transports, water pumping, ventilation (underground mining) and restoration of mines (only land use). Uranium concentration in studied mines varies between 0.1-15% U3O8 in open pit mines, average 1,3%. The average U3O8 concentration in underground mines is 1,7%. 1 kg uranium in ore in this study is assumed to contain 0,6 kg from open pit mines and 0,4 kg from underground mines. Uranium ore processing Uranium ore processing implying crushing, grinding, chemical processing (oxidation, leaching), metal extraction (ion-exchange), waste treatment and final treatment to receive the product - yellow cake - has been included, also with respect to longliving radioactive emissions of tailings. Construction phase of plant is included. Conversion Conversion (wet concept, UNH) of virgin U3O8 to UF6 is included, implying dissolvation of ''yellow cake'' (U3O8) in nitric acid, purification through solvent extraction, conversion to uranylnitrathexahydrate (UNH), denitrification to UO3, reduction to UO2, conversion to UF4 with hydrofluoric acid and reaction with fluor gas to UF6. Process efficiency is high (>99.8%). Construction phase and solid wastes in connection with demolition of plant is included. Enrichment Enrichment of virgin UF6 from a U235 content of about 0.7% to a content of 3-4% is included. Two methods have been inventoried: - gaseous diffusion UF6 is passed through a fine porous filter and U235 being slightly lighter than U238 moves faster which lead to a slightly higher concentration of U235 on the other side of the filter. The process must be repeated 1,200 times to yield the a concentration of 3% U235 and is very energyware intensive. - gas centrifugation The isotope U238 is heavier than U235 and the centrifugal forces will tend to separate the two by pressing U238 to the outer wall of the centrifuge while U235 stays closer to the axis. The process must be repeated many times, but the energyware consumption is still about ten times lower than for the diffusion process.

	Electricity consumed during enrichment using gaseous diffusion is generated with a nuclear power plant and a hard coal power plant for the French and the US-American enrichment plant, respectively. Consumption of chemicals and materials, other energyware and water as well as radionuclide emissions are other factors considered in the operation phase of the enrichment plants. The different nuclear power nations purchase of nuclear fuel enriched with either method has been taken into account. 77% of nuclear fuel used in the UCPTE* countries is assumed to have been enriched with the diffusion process (83% in France and 17% in USA) and 23% with the centrifugal process (74% in UK and 6% in Russia). Data concerning this distribution has been calculated based on figures from literature and on the main suppliers' market share. Construction phase of enrichment plants is included as well as energyware consumption and solid wastes during the demolition phase. Fuel fabrication Fuel fabrication of virgin uranium is included: solid UF6 is heated into gaseous state, conversion into uranium dioxide powder, compression into cylindrical pellets, sintering and grinding, pellets are placed in zircaloy (zirconium alloy) tubes, tubes are pressurized with helium and sealed to form fuel rods, rods are bundled into fuel assemblies. Literature data mainly from two plants - one in Germany and one in USA - have been used. Construction of plant is included as well as demolition. Nuclear power plant Two Swiss light water nuclear power plants have been inventoried with respect to construction, operation and demolition - one BWR (Boiling Water Reactor) and one PWR (Pressurized Water Reactor), both about 1000 MW e and 25500 TJ net electricity production per year. Data about construction and demolition has been adapted to UCPTE conditions (90% PWR and 10 % BWR). Country specific radionuclide emissions are applied for French, German and Swiss nuclear power plants. Test operation of diesel-fuelled reserve power is included. Reprocessing Though severel of the UCPTE* nuclear power nations do not use reprocessed fuel, all spent fuel is supposed to be reprocessed in ETH's study. UO2 pellets are dissolved in nitric acid and uranium and plutonium is regained. Construction, operation and demolition has been included. Interim storage Before and after reprocessing interim storages are needed for spent uranium fuel and radioactive wastes from the reprocessing plant respectively. The studied interim storage will store high, medium and low level radioactive products. The plant also includes a treatment plant for low level radioactive wastes (incineration and conditioning). Construction, operation and demolition of the plant are included. Final storage Two types of final storages have been included in the study, one for low and medium level radioactive wastes in horizontal caverns and one storage for high radioactive waste in vertical shafts deep in the mountain. Studied concepts are not built yet. Encapsulation is included. Construction, operation and sealing of the storages are included. Radionuclide emissions to groundwater are not included. Transports Transports of the interim products in the nuclear fuel chain between all plants have been included as well as transports of materials, chemicals and wastes. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries	
Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH. Vattenfall's criterion in selecting and aggregating ETH's LCI-results for electricity generation in the UCPTE region has been to make the figures usable as general electricity LCI data in EPDs according to Miljöstyrningsrådets guidelines. Especially parameters (emissions) which have established impact indices - accepted by the EPD system - for one or several environmental impact categories, have been picked out and aggregated as far possible. But also metal and energyware resources have been included, as well as waste, in spite of all waste handling processes related to this dataset being

	included with respect to use of resources and emissions. The latter is an adaption to other LCI data for electricity generation where waste amounts are reported (since those flows have not been followed to the grave). Since ETH claimes that most of the figures regarding metal emissions have an undefined amount of datagaps all metal emissions are aggregated except for a few which are specified separatly since they are reported for most processes in the lifecycle. Metals are reported as elements although they often are part of compounds. Measuring methods often just give the amounts of the different elements found. All hydrocarbons to water are aggregated to one parameter as well as halogenated organics, since no indices exist (that are accepted by the EPD system so far) for characterisation of the individual substances.
Time Boundary	The figures describe the average operation of studied plants in 1994. But for radioactive emissions figures mirrors the period from 1992-1994. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Conversion plant 40 years Enrichment plants 30 years Fuel fabriction 30 years Nuclear power plants 40 years Reprocessing plant 30-40 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	Only the following countries in the UCPTE* do have nuclear power: Germany, Belgium, France, The Netherlands, Switzerland, Slowenia and Spain. Data from one open-pit mine in Canada and two underground mines in the USA have been used as well as general literature data. Data for the uranium ore processing phase come from literature, one plant in Canada and two plants in the USA. Literature data describing American conversion plants have been used. Examined enrichment plants (literature data) are: EURODIF in France and USEC in the USA (gaseous diffusion); URENCO in Germany, UK and the Netherlands, and TENEX in Russia (gas centrifugation). Two Swiss nuclear power plants have been studied in detail concerning their actual fuel chain and their operation. Data received from the Swiss plants has been adapted to the average situation in the UCPTE* region in 1994 with the help of certain specific data from France and Germany. Data about radioactive emissions of nuclear power plants have been received from statistics in Switzerland, France and Germany. Figures from the most modern reprocessing plant in Sellafield, UK (THORP) and a prospected plant in Germany for spent uranium fuel have been used in the study together with other literature data. Studied storage concepts (interim and final) are Swiss. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	The restoration of uranium mines is not included in ETH's study except for land use. Demolition phase of uranium ore processing plant is excluded as well as environmental load on ground and ground water. Material need and energyware consumption in the demolition phase of conversion plant is not included, nor is treatment of operational solid waste. Regaining of hydrofluoric acid in the enrichment phase and the use of depleted UF_6 for further extraction of UO_2 has not been considered. Depleted UF_6 is neither considered as waste. Material need in the operation phase of diffusion plants and in the demolition phase of both kind of enrichment plants has been excluded. Diffusion process in France is supplied by nuclear power, and in USA by coal power. British and Russian centrifugal plants are supplied with UCPTE* electricity (mix of several power systems representativ for the actual situation in the UCPTE region).

	For the fuel fabrication plants data about some chemical use is missing and emissions during the demolition phase are not complete. Emissions to air and water in the demolition phase of nuclear power plant is not included. The reuse of extracted uranium and plutonium from spent fuel in nuclear power plant operation has not been taken into account. Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. The ETH study comprises figures concerning use of land, usable content in water storages and amount of turbine water which have not been reported here. The two latter have been excluded due to lack of corresponding data in comparable studies. Use of land has been excluded here because of ETH's advanced approach. Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the indutrial revolution I Modified human impact larger than other species', low degree of culivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of intererst. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is diffrent from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds. ETH specifies about 160 radioactive isotopes emitted to air and water. Radioactive emissions reported here are picked out in accordance with SETAC working group report on data quality and data availability (to be published in 2001). Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	Inventoried data from different literature references has been put together to form indata to the calculated modules within the nuclear fuel cycle: uranium mine, uranium ore processing, conversion, enrichment, fuel fabrication, nuclear power plant, reprocessing, interim storage and final storages for conditioned low, medium and high level radioactive waste. Criterias for chosing certain data is described in the original report from ETH. Criterias are different for different parameters. Allocation in the enrichment phase between different suppliers (diffusion and cetrifugation plants) has been done according to the assumed UCPTE purchase in 1994, i.e. 77% diffusion plants and 23% centrifugal plants. Generally the allocation between different ''stakeholders'' in all steps has been conducted according to the need of uranium and according to the need of uranium disposal. The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average nuclear power in the UCPTE countries.
Method	The data has been adapted from the Ökoinventare von Energiesystemen, ETH Zürich 1996 and is an aggregation of the LCI results for the module ''Electricity from nuclear power, UCPTE'' (Strom ab KKW, UCPTE). (KKW=Kernkraftwerk)

Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Bauxite	19.1			kg	Ground	
	Input	Natural resource	Chromium in ore	5.55			kg	Ground	
	Input	Natural resource	Copper in ore	2.26			kg	Ground	
Notes: From drillhole	Input	Natural resource	Crude oil	246			kg	Ground	
Notes: Before processing	Input	Natural resource	Hard coal	1260			kg	Ground	
	Input	Natural resource	Iron in ore	133			kg	Ground	
	Input	Natural resource	Lead in ore	0.0715			kg	Ground	
Notes: Before extraction	Input	Natural resource	Lignite	238			kg	Ground	
	Input	Natural resource	Limestone	163			kg	Ground	
	Input	Natural resource	Manganese in ore	0.206			kg	Ground	
Notes: Summation of ''Erdoelgas'' (40,9 MJ/Nm3), ''Grubengas'' (35,9 MJ/kg) and ''Rohgas'' (35 MJ/Nm3). Expressed as Natural gas with lower heating value (35 MJ/Nm3). The heating values are acquired from table III 8.1 in the methodology chapter in the Ökoinventare von Energiesystemen, ETH, Zürich 1996	Input	Natural resource	Natural gas	415.4			Nm3	Ground	
	Input	Natural resource	Nickel in ore	4.43			kg	Ground	
	Input	Natural resource	Palladium in ore	4.67E-08			kg	Ground	
	Input	Natural resource	Platinum in ore	5.43E-08			kg	Ground	
	Input	Natural resource	Rhodium in ore	5.00E-08			kg	Ground	
	Input	Natural resource	Rock salt	10.5			kg	Ground	
	Input	Natural resource	Uranium in ore	7.85			kg	Ground	
	Input	Natural resource	Water	2.53E+06			kg	Ground	
	Input	Natural resource	Wood	21.4			kg	Ground	
	Input	Natural resource	Zinc in ore	0.00453			kg	Ground	
Notes: Summation of Ag, Sn, Rh, Mo, Co.	Input	Refined resource	Metals	1.20E-03			kg	Technosphere	
	Output	Emission	1,2-Dichloroethane	3.91E-05			kg	Air	
	Output	Emission	Ag-110m	22.5			kBq	Water	
	Output	Emission	Ag-110m	3.22E-03			kBq	Air	
	Output	Emission	Am-241	6.04E-02			kBq	Air	
	Output	Emission	Am-241	7.96			kBq	Water	
Notes: BOD5	Output	Emission	BOD	2.24E-02			kg	Water	
	Output	Emission	C-14	403			kBq	Water	
	Output	Emission	C-14	4840			kBq	Air	
	Output	Emission	C-60	1.37E-01			kBq	Air	

	Output	Emission	Cd	1.30E-04			kg	Air	
	Output	Emission	Cd	3.77E-07			kg	Ground	
	Output	Emission	Cd	8.89E-04			kg	Water	
	Output	Emission	CFC-11	2.51E-03			kg	Air	
	Output	Emission	CFC-114	6.55E-02			kg	Air	
	Output	Emission	CFC-12	5.39E-04			kg	Air	
	Output	Emission	CFC-13	3.39E-04			kg	Air	
	Output	Emission	Cm alpha	10.5			kBq	Water	
	Output	Emission	Cm alpha	9.59E-02			kBq	Air	
	Output	Emission	Cm-244	2.82E-06			kBq	Air	
Notes: CN- is Cyanide ion	Output	Emission	CN-	3.97E-05			kg	Air	
	Output	Emission	CN-	6.25E-04			kg	Water	
	Output	Emission	CO	6.01			kg	Air	
	Output	Emission	CO2	3604.6			kg	Air	
	Output	Emission	Co-58	33.2			kBq	Water	
	Output	Emission	Co-58	9.27E-02			kBq	Air	
	Output	Emission	Co-60	1763.8			kBq	Water	
	Output	Emission	COD	0.09001			kg	Water	
	Output	Emission	Cr	1.10E-04			kg	Ground	
	Output	Emission	Cr	3.45E-02			kg	Water	
	Output	Emission	Cr	3.83E-04			kg	Air	
	Output	Emission	Cs-134	2.30E+00			kBq	Air	
	Output	Emission	Cs-134	407.62			kBq	Water	
	Output	Emission	Cs-137	3750.1			kBq	Water	
	Output	Emission	Cs-137	4.43			kBq	Air	
	Output	Emission	Dichloromethane	1.83E-05			kg	Air	
Notes: 2,3,7,8-Tetrachlorodibenzo-p-Dioxin-equivalents	Output	Emission	Dioxin (TCDD)	527			ng	Air	
	Output	Emission	Dissolved solids	0.8557			kg	Water	
	Output	Emission	H-1301	9.55E-05			kg	Air	
	Output	Emission	H2S	0.01321			kg	Air	
	Output	Emission	H-3	1.19E+07			kBq	Water	
	Output	Emission	H-3	50300			kBq	Air	
Notes: Summation of AOX, 1,1,1-trichloroethane, chlorobenzene, dichloromonofluoromethane, ethylene dichloride, hexachlororethane, metylenchloride, tetrachloroethylene, trichloroethylene, trichloromethane.	Output	Emission	Halogenated organics	2.51E-04			kg	Water	
Notes: Summation of Cl-, F- and I-.	Output	Emission	Halogenids	6.57E+01			kg	Water	
Notes: Summation of I and Br.	Output	Emission	Halogens	4.71E-03			kg	Air	
	Output	Emission	HCFC-21	2.00E-04			kg	Air	
	Output	Emission	HCFC-22	5.89E-04			kg	Air	
	Output	Emission	HCl	0.46048			kg	Air	
Notes: No available index. Same index as NMVOC.	Output	Emission	Hexachlorobenzene	1.22E-09			kg	Air	
	Output	Emission	Hexafluoroethane	2.08E-04			kg	Air	
	Output	Emission	HF	0.0922			kg	Air	
	Output	Emission	HFC-134a	2.18E-17			kg	Air	
	Output	Emission	Hg	2.04E-05			kg	Water	
	Output	Emission	Hg	2.28E-04			kg	Air	
	Output	Emission	Hg	5.68E-08			kg	Ground	
Notes: Summation of acenaphtene, acenaphtylene, alkane, alkene, aromats, benzene, butyl benzyl phtalat, bibutyl p-phtalat, dimethyl p-phtalat, ethylbenzen, volatile hydrocarbons, formaldehyd, glutaraldehyd, hydrocarbons, MTBE (Metyl Tertiary Butyl Eter), phenol, styrol, toluol, triethylenglycol, xylol.	Output	Emission	Hydrocarbons	7.67E-02			kg	Water	
	Output	Emission	I-129	1150			kBq	Water	
	Output	Emission	I-129	17.3			kBq	Air	

	Output	Emission	I-131	0.756			kBq	Water	
	Output	Emission	I-131	1.84			kBq	Air	
	Output	Emission	I-133	0.161			kBq	Water	
	Output	Emission	I-133	1.08			kBq	Air	
	Output	Emission	K-40	0.101			kBq	Air	
	Output	Emission	K-40	0.372			kBq	Water	
	Output	Emission	Kr-85	2.97E+08			kBq	Air	
Notes: Summation of the ions of following metals: Ag, Al, Ar, Ba, Be, Cs, Ca, Fe, K, Co, Mg, Mn, Mo, Na, Ni, Ru, Sb, Se, Sn, Sr, Ti, W.	Output	Emission	Metal ions	7.15E+01			kg	Water	
Notes: Summation of Al, As, Ca, Co, Cu, Fe, Mn, Ni, Sn.	Output	Emission	Metals	1.54E-01			kg	Ground	
Notes: Summation of Al, As, Ba, Be, Ca, Co, Cu, Fe, K, La, Mg, Mn, Mo, Ni, Pt, Sb, Sc, Se, Sn, Sr, Th, Ti, Tl, U, Zr.	Output	Emission	Metals	2.13E-01			kg	Air	
	Output	Emission	Methane	10.26077			kg	Air	
	Output	Emission	Mn-54	269.57			kBq	Water	
	Output	Emission	Mn-54	3.25E-03			kBq	Air	
	Output	Emission	N	1.82E-05			kg	Ground	
	Output	Emission	N total	1.49107			kg	Water	
	Output	Emission	N2O	0.07969			kg	Air	
	Output	Emission	NH3	0.05174			kg	Air	
Notes: Summation of acetaldehyd, acetylene, aceton, acrolein, aldehyd, alkane, alkene, aromats, benzaldehyd, benzene, butan, buten, acetic acid, etan, etanol, etene, ethylbenzene, ethylenoxide (C2H4O), formaldehyd, heptan, hexan, metanol, MTBE (Metyl Tertiary Butyl Eter), NMVOC, pentane, phenol, propan, propen, propion aldehyd, propionic acid, styrol, toluol, xylol.	Output	Emission	NMVOC	3.93E+00			kg	Air	
	Output	Emission	NO2-	3.07E-01			kg	Water	
	Output	Emission	NO3-	0.2488			kg	Water	
Notes: as NO2	Output	Emission	NOx	9.599			kg	Air	
	Output	Emission	Np-237	0.508			kBq	Water	
	Output	Emission	Oil	1.13E-02			kg	Ground	
	Output	Emission	Oil	2.52E-01			kg	Water	
	Output	Emission	P	0.00114			kg	Ground	
	Output	Emission	P total	8.96E-04			kg	Air	
	Output	Emission	PAH	2.63E-04			kg	Water	
Notes: Same index as NMVOC.	Output	Emission	PAH	4.50E-04			kg	Air	
	Output	Emission	Particles	7.0854			kg	Air	
	Output	Emission	Pb	1.54E-01			kg	Water	
	Output	Emission	Pb	1.73E-03			kg	Air	
	Output	Emission	Pb	7.56E-06			kg	Ground	
	Output	Emission	Pb-210	0.297			kBq	Water	
	Output	Emission	Pb-210	21.756			kBq	Air	
Notes: C6HCl5, no available index. Same index as NMVOC.	Output	Emission	Pentachlorobenzene	3.26E-09			kg	Air	
Notes: C6HCl5O, no available index. Same index as NMVOC.	Output	Emission	Pentachlorophenol	5.26E-10			kg	Air	
	Output	Emission	Po-210	0.297			kBq	Water	
	Output	Emission	Po-210	22.05			kBq	Air	
	Output	Emission	PO43-	1.28E-01			kg	Water	
	Output	Emission	Pu alpha	0.192			kBq	Air	
	Output	Emission	Pu alpha	31.6			kBq	Water	
	Output	Emission	Pu-238	7.03E-06			kBq	Air	
	Output	Emission	Ra-226	147001			kBq	Water	
	Output	Emission	Ra-226	60.2917			kBq	Air	
Notes: Long-term emissions of Rn-222	Output	Emission	Rn-222	4.27E+08			kBq	Air	
	Output	Emission	Rn-222	4.64E+06			kBq	Air	
	Output	Emission	Ru-106	19.2			kBq	Air	
	Output	Emission	Ru-106	1920			kBq	Water	

	Output	Emission	S	0.0132			kg	Ground	
Notes: Includes Tot-S, S-, S in H2S, S in sulphate, S in sulphite	Output	Emission	S total	1.62E+02			kg	Water	
	Output	Emission	Sb-124	5.71			kBq	Water	
	Output	Emission	Sb-124	8.79E-04			kBq	Air	
	Output	Emission	Sb-125	0.287			kBq	Water	
	Output	Emission	Sb-125	1.03E-04			kBq	Air	
	Output	Emission	SO2	25.131			kg	Air	
	Output	Emission	Sr-90	3.17			kBq	Air	
	Output	Emission	Sr-90	3.84E+02			kBq	Water	
	Output	Emission	Suspended solids	19.23			kg	Water	
	Output	Emission	Tc-99	1.34E-04			kBq	Air	
	Output	Emission	Tc-99	201			kBq	Water	
	Output	Emission	Tetrachloromethane	1.22E-05			kg	Air	
	Output	Emission	Tetrafluoromethane	0.00187			kg	Air	
	Output	Emission	Th-230	21.4			kBq	Air	
	Output	Emission	Th-230	5560			kBq	Water	
	Output	Emission	Th-232	0.0267			kBq	Air	
	Output	Emission	Th-232	0.0694			kBq	Water	
Notes: Summation of dissolved organic carbon, fat acids as C, volatile organic compounds as C, TOC.	Output	Emission	Total organic carbon	1.04E+00			kg	Water	
	Output	Emission	Tributyl tin	5.71E-05			kg	Water	
	Output	Emission	Trichloromethane	1.03E-06			kg	Air	
	Output	Emission	U-234	23			kBq	Air	
	Output	Emission	U-234	47.5			kBq	Water	
	Output	Emission	U-235	1.12			kBq	Air	
	Output	Emission	U-235	70.8			kBq	Water	
	Output	Emission	U-238	109			kBq	Water	
	Output	Emission	U-238	22.7764			kBq	Air	
	Output	Emission	V	6.62E-02			kg	Water	
	Output	Emission	V	6.83E-03			kg	Air	
	Output	Emission	Vinyl chloride	6.36E-06			kg	Air	
	Output	Emission	Xe-133	214000			kBq	Air	
	Output	Emission	Zn	3.46E-04			kg	Ground	
	Output	Emission	Zn	4.38E-02			kg	Water	
	Output	Emission	Zn	7.13E-03			kg	Air	
	Output	Product	Electricity	1			TJ	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) and processing of hazardous waste is included.	Output	Residue	Hazardous waste	2.86E+00			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Highly radioactive waste	1.34E-03			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, no emissions from landfill assumed. Inert waste deposit is waste at landfill that are inert.	Output	Residue	Inert waste deposit	1.29E+03			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Low radioactive waste	8.49E-03			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Medium and low radioactive waste	1.64E-02			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from landfill. Reactive waste deposit is waste at landfill that is still reactive.	Output	Residue	Reactive waste deposit	2.27E+02			kg	Technosphere	
Notes: Internal flow! Infrastructure of spreading vehicles and emissions are included. Land farming is a treatment of organic sludge, the sludge is spread on a piece of land and left to degrade. Sometimes plants are grown on the land, but	Output	Residue	Waste in land farming	2.30E+00			kg	Technosphere	

those plants are destroyed.									
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from incineration plant.	Output	Residue	Waste to incineration	1.17E+00			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www.energieforschung.ch. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frishknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their lifecycles. The results can be used in lifecycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans. Vattenfalls purpose - as a commissioner of putting ETH:s data into Spine format with metadata - is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines. Data is supposed to be used together with IEA statistics about electricity generation mixes in the OECD countries/regions.
Detailed Purpose	ETH:s aim of this LCI was to describe the averag situation in UCPTE concerning electricity generation with nuclear power. Material and energyware needs, emissions and solid waste have been inventoried in all steps of the nuclear fuel cycle regarding construction, operation and demolition phases all through the lifecycle.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Data reported here is supposed to be representative for nuclear power in the UCPTE countries in 1994. This set of data is aggregated and documented in accordance with the Swedish EPD-guidelines to be used in combination with IEA statistics concerning electricity generation mixes in OECD countries and regions together with other datasets - based on the ETH study - describing other power generation systems. The EPD-adapted power generation systems in Spine format are named as follows: Fuel gas electricity energy system, EPD-version Biofuel electricity energy system, EPD-version Hydro electricity energy system, EPD-version Lignite electricity energy system, EPD-version Nuclear electricity energy system, EPD-version Stone coal electricity energy system, EPD-version Wind electricity energy system, EPD-version IEA statistics for generation mixes 1998 exist in Spine format for the following 30 countries/regions: OECD total OECD North America OECD Pacific OECD Europe European Union Australia Austria Belgium Canada Czech Rpublic Denmark Finland France Germany Greece Hungary Iceland

	Ireland Italy Japan Korea Luxembourg Mexico Netherlands New Zealand Norway Poland Portugal Spain Sweden Switzerland Turkey United Kingdom United States
About Data	The exactitude concerning radioactive emissions to air and water is ±50%. Data concerning construction of UCPTE nuclear power is probably slightly overestimated since a major part of French and German nuclear power plants have a capacity of about 1300 MWe. Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided). Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of ETH:s data and metadata has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of aggregation of figures and of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. The technical committee of the Swedish Environmental Management Council - approval of method and aggregation of parameters Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut --- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 6 June 2001: <<< Changes made by Ann-Christin Pålsson, CPM based on discussions with Caroline Setterwall, Vattenfall AB. Comments: The following changes has been made in the nomenclature for in- and outflows: Mangane in ore -> changed to: Manganese in ore CH4 -> changed to: Methane (to be in accordance with the nomenclature specified in CPM report 2000:2) CN -> changed to: CN- Stone coal -> changed to: Hard coal (to be in accordance with the nomenclature specified in CPM report 2000:2) Other metals -> changed to: Metals Explanations of nomenclature (inserted in Notes for the specific flows): - CN- is Cyanide ion - Reactive waste deposit is waste at landfill that is still reactive. - Inert waste deposit is waste at landfill that are inert. Additional clarifications: - Note that the flows of waste in the table of in- and outflows are internal flows, i.e. they do NOT cross the system boundaries. All waste handling processes is included in the study with respect to use of resources and emissions. - Radioactive waste is accounted for in cubic metres. The product specific requirements for electricity and district heating generation (PSR 1998:1) in the Swedish EPD system states that waste shall be accounted for in gram. However, no conversion factors were given in the study. There are also no general conversion factors that are commonly used.

SPINE LCI dataset: Nuclear electricity energy system, ETH - full version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Nuclear electricity energy system, ETH - full version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures come from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996. Brief description The phases inventoried in ETH's life cycle study of nuclear power are: uranium mine, uranium ore processing, conversion, enrichment, fuel fabrication, nuclear power plant, reprocessing of spent fuel, interim and final storages for conditioned low, medium and high level radioactive waste. Data has been aquired from literature and figures concerning consumption of energyware and materials, use of land and water, emissions (radioactive and non-radioactive to air and water) and wastes have been picked out from or calculated based on literature and official reports from authorities where available for all phases of the life cycle. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle. Detailed description Uranium mine Underground and open pit mining has been studied including extraction work, transports, water pumping, ventilation (underground mining) and restoration of mines (only land use). Uranium concentration in studied mines varies between 0.1-15% U3O8 in open pit mines, average 1,3%. The average U3O8 concentration in underground mines is 1,7%. 1 kg uranium in ore in this study is assumed to contain 0,6 kg from open pit mines and 0,4 kg from underground mines. Uranium ore processing Uranium ore processing implying crushing, grinding, chemical processing (oxidation, leaching), metal extraction (ion-exchange), waste treatment and final treatment to receive the product - yellow cake - has been included, also with respect to longliving radioactive emissions of tailings. Construction phase of plant is included. Conversion Conversion (wet concept, UNH) of virgin U3O8 to UF6 is included, implying dissolvation of ''yellow cake'' (U3O8) in nitric acid, purification through solvent extraction, conversion to uranylnitrathexahydrate (UNH), denitrification to UO3, reduction to UO2, conversion to UF4 with hydrofluoric acid and reaction with fluor gas to UF6. Process efficiency is high (>99.8%). Construction phase and solid wastes in connection with demolition of plant is included.

Enrichment
Enrichment of virgin UF6 from a U235 content of about 0.7% to a content of 3-4% is included. Two methods have been inventoried:
- gaseous diffusion
UF6 is passed through a fine porous filter and U235 being slightly lighter than U238 moves faster which lead to a slightly higher concentration of U235 on the other side of the filter. The process must be repeated 1,200 times to yield the a concentration of 3% U235 and is very energyware intensive.
- gas centrifugation
The isotope U238 is heavier than U235 and the centrifugal forces will tend to separate the two by pressing U238 to the outer wall of the centrifuge while U235 stays closer to the axis. The process must be repeated many times, but the energyware consumption is still about ten times lower than for the diffusion process.

Electricity consumed during enrichment using gaseous diffusion is generated with a nuclear power plant and a hard coal power plant for the French and the US-American enrichment plant, respectively. Consumption of chemicals and materials, other energyware and water as well as radionuclide emissions are other factors considered in the operation phase of the enrichment plants.

The different nuclear power nations purchase of nuclear fuel enriched with either method has been taken into account. 77% of nuclear fuel used in the UCPTE* countries is assumed to have been enriched with the diffusion process (83% in France and 17% in USA) and 23% with the centrifugal process (74% in UK and 6% in Russia). Data concerning this distribution has been calculated based on figures from literature and on the main suppliers' market share.

Construction phase of enrichment plants is included as well as energyware consumption and solid wastes during the demolition phase.

Fuel fabrication
Fuel fabrication of virgin uranium is included: solid UF6 is heated into gaseous state, conversion into uranium dioxide powder, compression into cylindrical pellets, sintering and grinding, pellets are placed in zircaloy (zirconium alloy) tubes, tubes are pressurized with helium and sealed to form fuel rods, rods are bundled into fuel assemblies. Literature data mainly from two plants - one in Germany and one in USA - have been used. Construction of plant is included as well as demolition.

Nuclear power plant
Two Swiss light water nuclear power plants have been inventoried with respect to construction, operation and demolition - one BWR (Boiling Water Reactor) and one PWR (Pressurized Water Reactor), both about 1000 MW e and 25500 TJ net electricity production per year. Data about construction and demolition has been adapted to UCPTE conditions (90% PWR and 10 % BWR). Country specific radionuclide emissions are applied for French, German and Swiss nuclear power plants. Test operation of diesel-fuelled reserve power is included.

Reprocessing
Though severel of the UCPTE* nuclear power nations do not use reprocessed fuel, all spent fuel is supposed to be reprocessed in ETH's study. UO2 pellets are dissolved in nitric acid and uranium and plutonium is regained. Construction, operation and demolition has been included.

Interim storage
Before and after reprocessing interim storages are needed for spent uranium fuel and radioactive wastes from the reprocessing plant respectively. The studied interim storage will store high, medium and low level radioactive products. The plant also includes a treatment plant for low level radioactive wastes (incineration and conditioning). Construction, operation and demolition of the plant are included.

Final storage
Two types of final storages have been included in the study, one for low and medium level radioactive wastes in horizontal caverns and one storage for high radioactive waste in vertical shafts deep in the mountain. Studied concepts are not built yet. Encapsulation is included. Construction, operation and sealing of the storages are included. Radionuclide emissions to groundwater are not included.

Transports
Transports of the interim products in the nuclear fuel chain between all plants have been included as well as transports of materials, chemicals and wastes.

* Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries

Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from

	landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the industrial revolution I Modified human impact larger than other species', low degree of cultivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of interest. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is different from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH.
Time Boundary	The figures describe the average operation of studied plants in 1994. But for radioactive emissions figures mirrors the period from 1992-1994. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Conversion plant 40 years Enrichment plants 30 years Fuel fabriction 30 years Nuclear power plants 40 years Reprocessing plant 30-40 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	Only the following countries in the UCPTE* do have nuclear power: Germany, Belgium, France, The Netherlands, Switzerland, Slowenia and Spain. Data from one open-pit mine in Canada and two underground mines in the USA have been used as well as general literature data. Data for the uranium ore processing phase come from literature, one plant in Canada and two plants in the USA. Literature data describing American conversion plants have been used. Examined enrichment plants (literature data) are: EURODIF in France and USEC in the USA (gaseous diffusion); URENCO in Germany, UK and the Netherlands, and TENEX in Russia (gas centrifugation). Two Swiss nuclear power plants have been studied in detail concerning their actual fuel chain and their operation. Data received from the Swiss plants has been adapted to the average situation in the UCPTE* region in 1994 with the help of certain specific data from France and Germany. Data about radioactive emissions of nuclear power plants have been received from statistics in Switzerland, France and Germany. Figures from the most modern reprocessing plant in Sellafield, UK (THORP) and a prospected plant in Germany for spent uranium fuel have been used in the study together with other literature data. Studied storage concepts (interim and final) are Swiss. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following

	countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	The restoration of uranium mines is not included in ETH's study except for land use. Demolition phase of uranium ore processing plant is excluded as well as environmental load on ground and ground water. Material need and energyware consumption in the demolition phase of conversion plant is not included, nor is treatment of operational solid waste. Regaining of hydrofluoric acid in the enrichment phase and the use of depleted UF6 for further extraction of UO2 has not been considered. Depleted UF6 is neither considered as waste. Material need in the operation phase of diffusion plants and in the demolition phase of both kind of enrichment plants has been excluded. Diffusion process in France is supplied by nuclear power, and in USA by coal power. British and Russian centrifugal plants are supplied with UCPTE* electricity (mix of several power systems representativ for the actual situation in the UCPTE region). For the fuel fabrication plants data about some chemical use is missing and emissions during the demolition phase are not complete. Emissions to air and water in the demolition phase of nuclear power plant is not included. The reuse of extracted uranium and plutonium from spent fuel in nuclear power plant operation has not been taken into account. Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	Inventoried data from different literature references has been put together to form indata to the calculated modules within the nuclear fuel cycle: uranium mine, uranium ore processing, conversion, enrichment, fuel fabrication, nuclear power plant, reprocessing, interim storage and final storages for conditioned low, medium and high level radioactive waste. Criterias for chosing certain data is described in the original report from ETH. Criterias are different for different parameters. Allocation in the enrichment phase between different suppliers (diffusion and cetrifugation plants) has been done according to the assumed UCPTE purchase in 1994, i.e. 77% diffusion plants and 23% centrifugal plants. Generally the allocation between different ''stakeholders'' in all steps has been conducted according to the need of uranium and according to the need of uranium disposal. The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average nuclear power in the UCPTE countries.
Method	The figures have been copied from the module '''Electricity from nuclear power, UCPTE'' (Strom ab KKW, UCPTE) (KKW=Kernkraftwerk) in the Ökoinventare von Energiesystemen, ETH Zürich 1996.
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	Multiple flows are reported for several emissions to air. This is because that in the original study emissions to air have been reported in three categories, indicated by one of the letters below following the substance name. - m = mobile (emissions from vehicles) - p = process (process specific emissions as for instance methane emissions during coal mining) - s = stationary (emissions from stationary combustion plants) This categorisation has however not been documented in this specification in the SPINE format.

Flow Table and Specific Meta Data									
QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Area II-III	27800			m2a	Ground	
	Input	Natural resource	Area III-IV	7.81			m2a	Ground	
	Input	Natural resource	Area II-IV	49			m2a	Ground	
	Input	Natural resource	Area IV-IV	0.196			m2a	Ground	
	Input	Natural resource	Area, sea bed II-III	26.6			m2a	Ground	
	Input	Natural resource	Area, sea bed II-IV	2.75			m2a	Ground	
	Input	Natural resource	Barite	1.67			kg	Ground	
	Input	Natural resource	Bauxite	19.1			kg	Ground	
	Input	Natural resource	Bentonite	95.9			kg	Ground	
	Input	Natural resource	Chromium in ore	5.55			kg	Ground	
	Input	Natural resource	Clay	30.2			kg	Ground	
	Input	Natural resource	Copper in ore	2.26			kg	Ground	
	Input	Natural resource	Crude oil	0.246			tonne	Ground	
	Input	Natural resource	Gravel	724			kg	Ground	
	Input	Natural resource	Hydro energy	0.00199			TJ	Water	
	Input	Natural resource	Iron in ore	133			kg	Ground	
	Input	Natural resource	Lead in ore	0.0715			kg	Ground	
	Input	Natural resource	Lignite	238			kg	Ground	
	Input	Natural resource	Limestone	163			kg	Ground	
	Input	Natural resource	Manganese in ore	0.206			kg	Ground	
	Input	Natural resource	Mine gas (methane)	8.59			kg	Ground	
	Input	Natural resource	Natural gas	16.8			Nm3	Ground	
	Input	Natural resource	Natural gas	387			Nm3	Ground	
	Input	Natural resource	Nickel in ore	4.43			kg	Ground	
	Input	Natural resource	Palladium in ore	4.67E-08			kg	Ground	
	Input	Natural resource	Platinum in ore	5.43E-08			kg	Ground	
	Input	Natural resource	Rhodium in ore	0.00000005			kg	Ground	
	Input	Natural resource	Rock salt	10.5			kg	Ground	
	Input	Natural resource	Sand	115			kg	Ground	
	Input	Natural resource	Stone coal	1260			kg	Ground	
	Input	Natural resource	Turbine water amount	9700			m3	Water	
	Input	Natural resource	Uranium in ore	7.85			kg	Ground	
	Input	Natural resource	Water	2530000			kg	Ground	
	Input	Natural resource	Wood	0.0214			tonne	Ground	
	Input	Natural resource	Working amount in water storages	44.3			m3a	Water	

	Input	Natural resource	Zinc in ore	0.00453			kg	Ground	
	Input	Refined resource	Cobalt	0.000000423			kg	Technosphere	
	Input	Refined resource	Molybdenum	0.000000308			kg	Technosphere	
	Input	Refined resource	Rhenium	4.52E-08			kg	Technosphere	
	Input	Refined resource	Silver	0.000772			kg	Technosphere	
	Input	Refined resource	Tin	0.000429			kg	Technosphere	
	Output	Emission	1,1,1-Trichloroethane	6.32E-08			kg	Fresh water	
	Output	Emission	1,2-Dichloroethane	0.0000201			kg	Fresh water	
	Output	Emission	1,2-Dichloroethane	0.0000391			kg	Air	
	Output	Emission	Acenaphthylene	0.000182			kg	Fresh water	
	Output	Emission	Acetaldehyde	0.000521			kg	Air	
	Output	Emission	Acetic acid	0.00384			kg	Air	
	Output	Emission	Acetone	0.000506			kg	Air	
	Output	Emission	Acetylene	0.000201			kg	Air	
	Output	Emission	Acids	0.0106			kg	Fresh water	
	Output	Emission	Acroleine	0.00000013			kg	Air	
	Output	Emission	Ag	0.00000646			kg	Sea water	
	Output	Emission	Ag	0.0000463			kg	Fresh water	
	Output	Emission	Ag-110m	0.00322			kBq	Air	
	Output	Emission	Ag-110m	22.5			kBq	Fresh water	
	Output	Emission	Al	0.000017			kg	Sea water	
	Output	Emission	Al	0.0000832			kg	Air	
	Output	Emission	Al	0.000831			kg	Air	
	Output	Emission	Al	0.0219			kg	Ground	
	Output	Emission	Al	0.062			kg	Air	
	Output	Emission	Al	7.02			kg	Fresh water	
	Output	Emission	Aldehydes	0.00626			kg	Air	
	Output	Emission	Alkanes	0.000243			kg	Fresh water	
	Output	Emission	Alkanes	0.0014			kg	Sea water	
	Output	Emission	Alkanes	0.00507			kg	Air	
	Output	Emission	Alkanes	0.00722			kg	Air	
	Output	Emission	Alkenes	0.0000125			kg	Air	
	Output	Emission	Alkenes	0.0000224			kg	Fresh water	
	Output	Emission	Alkenes	0.000129			kg	Sea water	
	Output	Emission	Alkenes	0.00454			kg	Air	
	Output	Emission	Alpha radiator	0.0026			kBq	Fresh water	
	Output	Emission	Am-241	0.0604			kBq	Air	
	Output	Emission	Am-241	7.96			kBq	Sea water	
	Output	Emission	AOX	0.0000163			kg	Sea water	
	Output	Emission	AOX	0.0000307			kg	Fresh water	
	Output	Emission	Ar-41	6990			kBq	Air	
	Output	Emission	Aromates	0.00000125			kg	Air	
	Output	Emission	Aromates	0.000349			kg	Air	
	Output	Emission	Aromatics	0.000786			kg	Fresh water	
	Output	Emission	Aromatics	0.00707			kg	Sea water	
	Output	Emission	As	0.00000344			kg	Sea water	
	Output	Emission	As	0.00000832			kg	Air	
	Output	Emission	As	0.00000878			kg	Ground	
	Output	Emission	As	0.0000319			kg	Air	
	Output	Emission	As	0.000177			kg	Air	
	Output	Emission	As	0.00584			kg	Fresh water	
	Output	Emission	B	0.00000209			kg	Air	
	Output	Emission	B	0.00309			kg	Fresh water	
	Output	Emission	B	0.0126			kg	Sea water	
	Output	Emission	B	0.0133			kg	Air	
	Output	Emission	Ba	0.00000768			kg	Air	
	Output	Emission	Ba	0.000818			kg	Air	
	Output	Emission	Ba	0.027			kg	Sea water	
	Output	Emission	Ba	0.18			kg	Fresh water	
	Output	Emission	Ba-140	0.0123			kBq	Air	

	Output	Emission	Ba-140	0.035			kBq	Fresh water	
	Output	Emission	Barite	0.332			kg	Sea water	
	Output	Emission	Be	0.00000302			kg	Air	
	Output	Emission	Be	0.00000913			kg	Air	
	Output	Emission	Be	0.0002			kg	Fresh water	
	Output	Emission	Benzaldehyde	0.000000068			kg	Air	
	Output	Emission	Benzene	0.0000476			kg	Air	
	Output	Emission	Benzene	0.000264			kg	Fresh water	
	Output	Emission	Benzene	0.0014			kg	Sea water	
	Output	Emission	Benzene	0.00277			kg	Air	
	Output	Emission	Benzene	0.00548			kg	Air	
	Output	Emission	Benzo(a)pyrene	0.0000132			kg	Air	
	Output	Emission	Benzo(a)pyrene	8.24E-08			kg	Air	
	Output	Emission	BOD	0.000285			kg	Sea water	
	Output	Emission	BOD	0.0221			kg	Fresh water	
	Output	Emission	Br	0.00000929			kg	Air	
	Output	Emission	Br	0.00367			kg	Air	
	Output	Emission	Butane	0.00985			kg	Air	
	Output	Emission	Butane	0.024			kg	Air	
	Output	Emission	Butene	0.00108			kg	Air	
	Output	Emission	C	0.0673			kg	Ground	
	Output	Emission	C-14	403			kBq	Sea water	
	Output	Emission	C-14	4840			kBq	Air	
	Output	Emission	Ca	0.000072			kg	Air	
	Output	Emission	Ca	0.00501			kg	Air	
	Output	Emission	Ca	0.0256			kg	Air	
	Output	Emission	Ca	0.0878			kg	Ground	
	Output	Emission	Ca	0.349			kg	Sea water	
	Output	Emission	Ca	23.3			kg	Fresh water	
	Output	Emission	Cd	0.000000377			kg	Ground	
	Output	Emission	Cd	0.00000061			kg	Air	
	Output	Emission	Cd	0.00000689			kg	Sea water	
	Output	Emission	Cd	0.0000645			kg	Air	
	Output	Emission	Cd	0.0000647			kg	Air	
	Output	Emission	Cd	0.000882			kg	Fresh water	
	Output	Emission	Cd-109	0.000203			kBq	Fresh water	
	Output	Emission	Ce-141	0.000297			kBq	Air	
	Output	Emission	Ce-141	0.00524			kBq	Fresh water	
	Output	Emission	Ce-144	0.00149			kBq	Fresh water	
	Output	Emission	Ce-144	0.642			kBq	Air	
	Output	Emission	Ce-144	182			kBq	Sea water	
	Output	Emission	CFC-11	0.00251			kg	Air	
	Output	Emission	CFC-114	0.0655			kg	Air	
	Output	Emission	CFC-12	0.000539			kg	Air	
	Output	Emission	CFC-13	0.000339			kg	Air	
	Output	Emission	CH4	0.00577			kg	Air	
	Output	Emission	CH4	0.155			kg	Air	
	Output	Emission	CH4	10.1			kg	Air	
	Output	Emission	Chlorinated solvents	0.0000148			kg	Fresh water	
	Output	Emission	Chlorobenzenes	1.87E-10			kg	Fresh water	
	Output	Emission	Cl-	5.52			kg	Sea water	
	Output	Emission	Cl-	60.1			kg	Fresh water	
	Output	Emission	ClO-	0.000517			kg	Sea water	
	Output	Emission	ClO-	0.00715			kg	Fresh water	
	Output	Emission	Cm alpha	0.0959			kBq	Air	
	Output	Emission	Cm alpha	10.5			kBq	Sea water	
	Output	Emission	Cm-242	0.000000311			kBq	Air	
	Output	Emission	Cm-244	0.00000282			kBq	Air	
	Output	Emission	CN	0.0000397			kg	Air	
	Output	Emission	CN	8.28E-11			kg	Air	
	Output	Emission	CN-	0.000017			kg	Sea water	
	Output	Emission	CN-	0.000608			kg	Fresh water	
	Output	Emission	Co	0.00000033			kg	Ground	
	Output	Emission	Co	0.00000525			kg	Air	
	Output	Emission	Co	0.0000117			kg	Air	

	Output	Emission	Co	0.000181			kg	Air	
	Output	Emission	Co	0.00405			kg	Fresh water	
	Output	Emission	CO	0.21			kg	Air	
	Output	Emission	CO	1.66			kg	Air	
	Output	Emission	CO	4.14			kg	Air	
	Output	Emission	CO2	107			kg	Air	
	Output	Emission	CO2	3410			kg	Air	
	Output	Emission	CO2	87.6			kg	Air	
	Output	Emission	Co-57	0.00000552			kBq	Air	
	Output	Emission	Co-57	0.036			kBq	Fresh water	
	Output	Emission	Co-58	0.0927			kBq	Air	
	Output	Emission	Co-58	33.2			kBq	Fresh water	
	Output	Emission	Co-60	0.137			kBq	Air	
	Output	Emission	Co-60	1730			kBq	Sea water	
	Output	Emission	Co-60	33.8			kBq	Fresh water	
	Output	Emission	COD	0.00831			kg	Sea water	
	Output	Emission	COD	0.0817			kg	Fresh water	
	Output	Emission	Cr	0.00000414			kg	Air	
	Output	Emission	Cr	0.000106			kg	Air	
	Output	Emission	Cr	0.00011			kg	Ground	
	Output	Emission	Cr	0.000273			kg	Air	
	Output	Emission	Cr(VI)	0.00000397			kg	Fresh water	
	Output	Emission	Cr3+	0.000173			kg	Sea water	
	Output	Emission	Cr3+	0.0343			kg	Fresh water	
	Output	Emission	Cr-51	0.0112			kBq	Air	
	Output	Emission	Cr-51	0.831			kBq	Fresh water	
	Output	Emission	Cs	0.00000168			kg	Fresh water	
	Output	Emission	Cs	0.0000108			kg	Sea water	
	Output	Emission	Cs-134	2.3			kBq	Air	
	Output	Emission	Cs-134	4.62			kBq	Fresh water	
	Output	Emission	Cs-134	403			kBq	Sea water	
	Output	Emission	Cs-136	0.000188			kBq	Fresh water	
	Output	Emission	Cs-137	10.1			kBq	Fresh water	
	Output	Emission	Cs-137	3740			kBq	Sea water	
	Output	Emission	Cs-137	4.43			kBq	Air	
	Output	Emission	Cu	0.00000165			kg	Ground	
	Output	Emission	Cu	0.0000173			kg	Sea water	
	Output	Emission	Cu	0.000782			kg	Air	
	Output	Emission	Cu	0.0016			kg	Air	
	Output	Emission	Cu	0.00198			kg	Air	
	Output	Emission	Cu	0.0145			kg	Fresh water	
	Output	Emission	Di-(2-ethylhexyl) phthalate	2.26E-09			kg	Fresh water	
	Output	Emission	Dibutyl p-phthalate	1.85E-08			kg	Fresh water	
	Output	Emission	Dichloromethane	0.0000183			kg	Air	
	Output	Emission	Dichloromethane	0.000153			kg	Fresh water	
	Output	Emission	Different beta	0.00037			kBq	Air	
	Output	Emission	Dimethyl p-phthalate	0.000000116			kg	Fresh water	
	Output	Emission	Dioxin (TCDD)	527			ng	Air	
	Output	Emission	Dissolved organic carbon	0.00114			kg	Sea water	
	Output	Emission	Dissolved organic carbon	0.00457			kg	Fresh water	
	Output	Emission	Dissolved solids	0.0757			kg	Sea water	
	Output	Emission	Dissolved solids	0.78			kg	Fresh water	
	Output	Emission	Ethane	0.00179			kg	Air	
	Output	Emission	Ethane	0.0809			kg	Air	
	Output	Emission	Ethanol	0.00101			kg	Air	
	Output	Emission	Ethanol	0.00163			kg	Air	
	Output	Emission	Ethene	0.00265			kg	Air	
	Output	Emission	Ethene	0.0211			kg	Air	
	Output	Emission	Ethylbenzene	0.0000334			kg	Fresh water	
	Output	Emission	Ethylbenzene	0.000258			kg	Sea water	
	Output	Emission	Ethylbenzene	0.000462			kg	Air	
	Output	Emission	Ethylbenzene	0.00414			kg	Air	
	Output	Emission	F-	0.000112			kg	Sea water	
	Output	Emission	F-	0.0783			kg	Fresh water	
	Output	Emission	Fe	0.00016			kg	Air	

	Output	Emission	Fe	0.0013			kg	Sea water	
	Output	Emission	Fe	0.00817			kg	Air	
	Output	Emission	Fe	0.0337			kg	Air	
	Output	Emission	Fe	0.0439			kg	Ground	
	Output	Emission	Fe	2.99			kg	Fresh water	
	Output	Emission	Fe-59	0.000123			kBq	Air	
	Output	Emission	Fe-59	0.000621			kBq	Fresh water	
	Output	Emission	Fission and rad. prod.	22.3			kBq	Fresh water	
	Output	Emission	Formaldehyde	0.00000529			kg	Fresh water	
	Output	Emission	Formaldehyde	0.00000575			kg	Air	
	Output	Emission	Formaldehyde	0.00648			kg	Air	
	Output	Emission	Glutaraldehyde	0.000041			kg	Sea water	
	Output	Emission	H-1301	0.0000955			kg	Air	
	Output	Emission	H2S	0.000175			kg	Fresh water	
	Output	Emission	H2S	0.00614			kg	Air	
	Output	Emission	H2S	0.00707			kg	Air	
	Output	Emission	H-3	11500000			kBq	Sea water	
	Output	Emission	H-3	425000			kBq	Fresh water	
	Output	Emission	H-3	50300			kBq	Air	
	Output	Emission	HCFC-21	0.0002			kg	Air	
	Output	Emission	HCFC-22	0.000589			kg	Air	
	Output	Emission	HCl	0.00648			kg	Air	
	Output	Emission	HCl	0.454			kg	Air	
	Output	Emission	He	0.00221			kg	Air	
	Output	Emission	He	0.0147			kg	Air	
	Output	Emission	Heat	0.0000696			TJ	Ground	
	Output	Emission	Heat	0.000169			TJ	Sea water	
	Output	Emission	Heat	0.00127			TJ	Fresh water	
	Output	Emission	Heat	0.00133			TJ	Air	
	Output	Emission	Heat	0.00193			TJ	Air	
	Output	Emission	Heat	2.33			TJ	Air	
	Output	Emission	Heptane	0.00462			kg	Air	
	Output	Emission	Hexachlorobenzene	1.22E-09			kg	Air	
	Output	Emission	Hexachloroethane	4.46E-10			kg	Fresh water	
	Output	Emission	Hexafluoroethane	0.000208			kg	Air	
	Output	Emission	Hexane	0.00968			kg	Air	
	Output	Emission	HF	0.0214			kg	Air	
	Output	Emission	HF	0.0708			kg	Air	
	Output	Emission	HFC-134a	2.18E-17			kg	Air	
	Output	Emission	Hg	0.000000243			kg	Air	
	Output	Emission	Hg	0.000000285			kg	Sea water	
	Output	Emission	Hg	0.0000109			kg	Air	
	Output	Emission	Hg	0.0000201			kg	Fresh water	
	Output	Emission	Hg	0.000217			kg	Air	
	Output	Emission	Hg	5.68E-08			kg	Ground	
	Output	Emission	HOCl	0.000517			kg	Sea water	
	Output	Emission	HOCl	0.00715			kg	Fresh water	
	Output	Emission	Hydrocarbons	0.05			kg	Fresh water	
	Output	Emission	I	0.0000075			kg	Air	
	Output	Emission	I	0.000138			kg	Fresh water	
	Output	Emission	I	0.00102			kg	Air	
	Output	Emission	I	0.00108			kg	Sea water	
	Output	Emission	I-129	1150			kBq	Sea water	
	Output	Emission	I-129	17.3			kBq	Air	
	Output	Emission	I-131	0.756			kBq	Fresh water	
	Output	Emission	I-131	1.84			kBq	Air	
	Output	Emission	I-133	0.161			kBq	Fresh water	
	Output	Emission	I-133	1.08			kBq	Air	
	Output	Emission	I-135	1.62			kBq	Air	
	Output	Emission	K	0.00797			kg	Air	
	Output	Emission	K	0.0229			kg	Air	
	Output	Emission	K	0.0468			kg	Sea water	
	Output	Emission	K	0.621			kg	Fresh water	
	Output	Emission	K-40	0.101			kBq	Air	
	Output	Emission	K-40	0.372			kBq	Fresh water	

	Output	Emission	Kr-85	297000000			kBq	Air	
	Output	Emission	Kr-85m	324			kBq	Air	
	Output	Emission	Kr-87	149			kBq	Air	
	Output	Emission	Kr-88	14100			kBq	Air	
	Output	Emission	Kr-89	102			kBq	Air	
	Output	Emission	La	0.000000384			kg	Air	
	Output	Emission	La	0.0000255			kg	Air	
	Output	Emission	La-140	0.00726			kBq	Fresh water	
	Output	Emission	La-140	0.00788			kBq	Air	
	Output	Emission	Methanol	0.00123			kg	Air	
	Output	Emission	Methyl Tertiary Butyl Ether	0.000000102			kg	Sea water	
	Output	Emission	Methyl Tertiary Butyl Ether	0.000000178			kg	Fresh water	
	Output	Emission	Methyl Tertiary Butyl Ether	0.00000336			kg	Air	
	Output	Emission	Mg	0.000587			kg	Air	
	Output	Emission	Mg	0.0068			kg	Sea water	
	Output	Emission	Mg	0.018			kg	Air	
	Output	Emission	Mg	2.57			kg	Fresh water	
	Output	Emission	Mn	0.000247			kg	Air	
	Output	Emission	Mn	0.00065			kg	Sea water	
	Output	Emission	Mn	0.000878			kg	Ground	
	Output	Emission	Mn	0.00607			kg	Air	
	Output	Emission	Mn	0.568			kg	Fresh water	
	Output	Emission	Mn-54	0.00325			kBq	Air	
	Output	Emission	Mn-54	1.57			kBq	Fresh water	
	Output	Emission	Mn-54	268			kBq	Sea water	
	Output	Emission	Mo	0.000000114			kg	Air	
	Output	Emission	Mo	0.00000341			kg	Sea water	
	Output	Emission	Mo	0.00000666			kg	Air	
	Output	Emission	Mo	0.0000943			kg	Air	
	Output	Emission	Mo	0.142			kg	Fresh water	
	Output	Emission	Mo-99	0.00266			kBq	Fresh water	
	Output	Emission	N	0.0000182			kg	Ground	
	Output	Emission	N total	0.00716			kg	Sea water	
	Output	Emission	N total	0.0156			kg	Fresh water	
	Output	Emission	N2	0.109			kg	Air	
	Output	Emission	N2O	0.00589			kg	Air	
	Output	Emission	N2O	0.0335			kg	Air	
	Output	Emission	N2O	0.0403			kg	Air	
	Output	Emission	Na	0.0000384			kg	Air	
	Output	Emission	Na	0.000425			kg	Air	
	Output	Emission	Na	0.00665			kg	Air	
	Output	Emission	Na	3.35			kg	Sea water	
	Output	Emission	Na	30			kg	Fresh water	
	Output	Emission	Na-24	1.08			kBq	Fresh water	
	Output	Emission	Nb-95	0.000576			kBq	Air	
	Output	Emission	Nb-95	0.0199			kBq	Fresh water	
	Output	Emission	NH3	0.00064			kg	Air	
	Output	Emission	NH3	0.0511			kg	Air	
	Output	Emission	NH4+ as N	0.0054			kg	Sea water	
	Output	Emission	NH4+ as N	1.46			kg	Fresh water	
	Output	Emission	Ni	0.00000248			kg	Ground	
	Output	Emission	Ni	0.0000444			kg	Sea water	
	Output	Emission	Ni	0.000414			kg	Air	
	Output	Emission	Ni	0.00159			kg	Air	
	Output	Emission	Ni	0.00186			kg	Air	
	Output	Emission	Ni	0.0135			kg	Fresh water	
	Output	Emission	NMVOC	0.0874			kg	Air	
	Output	Emission	NMVOC	0.404			kg	Air	
	Output	Emission	NMVOC	3.12			kg	Air	
	Output	Emission	NO2-	0.00000782			kg	Fresh water	
	Output	Emission	NO2-	0.307			kg	Sea water	
	Output	Emission	NO3-	0.0028			kg	Sea water	
	Output	Emission	NO3-	0.246			kg	Fresh water	
	Output	Emission	Noble gases (radioactive)	371			kBq	Air	
	Output	Emission	NOx	0.569			kg	Air	

		Output	Emission	NOx	1.12			kg	Air	
		Output	Emission	NOx	7.91			kg	Air	
		Output	Emission	Np-237	0.00000316			kBq	Air	
		Output	Emission	Np-237	0.508			kBq	Sea water	
		Output	Emission	Nuclide mix	0.017			kBq	Fresh water	
		Output	Emission	Oil	0.000313			kg	Ground	
		Output	Emission	Oil	0.008			kg	Fresh water	
		Output	Emission	Oil	0.233			kg	Sea water	
		Output	Emission	Organic N	0.00104			kg	Sea water	
		Output	Emission	Organic N	0.00187			kg	Fresh water	
		Output	Emission	P	0.00000658			kg	Air	
		Output	Emission	P	0.0000486			kg	Air	
		Output	Emission	P	0.000841			kg	Air	
		Output	Emission	P	0.00114			kg	Ground	
		Output	Emission	P	0.011			kg	Ground	
		Output	Emission	Pa-234m	1.92			kBq	Air	
		Output	Emission	Pa-234m	35.6			kBq	Fresh water	
		Output	Emission	PAH	0.00000101			kg	Air	
		Output	Emission	PAH	0.000123			kg	Fresh water	
		Output	Emission	PAH	0.00014			kg	Sea water	
		Output	Emission	PAH	0.000436			kg	Air	
		Output	Emission	Particles	0.0654			kg	Air	
		Output	Emission	Particles	1.26			kg	Air	
		Output	Emission	Particles	5.76			kg	Air	
		Output	Emission	Pb	0.00000756			kg	Ground	
		Output	Emission	Pb	0.0000115			kg	Sea water	
		Output	Emission	Pb	0.000417			kg	Air	
		Output	Emission	Pb	0.000476			kg	Air	
		Output	Emission	Pb	0.000839			kg	Air	
		Output	Emission	Pb	0.154			kg	Fresh water	
		Output	Emission	Pb-210	0.297			kBq	Fresh water	
		Output	Emission	Pb-210	0.356			kBq	Air	
		Output	Emission	Pb-210	21.4			kBq	Air	
		Output	Emission	Pentachlorobenzene	3.26E-09			kg	Air	
		Output	Emission	Pentachlorophenol	5.26E-10			kg	Air	
		Output	Emission	Pentane	0.0182			kg	Air	
		Output	Emission	Pentane	0.0244			kg	Air	
		Output	Emission	Phenol	0.00000509			kg	Air	
		Output	Emission	Phenol	0.00105			kg	Fresh water	
		Output	Emission	Phenol	0.00125			kg	Sea water	
		Output	Emission	Phosphoric compound	0.00025			kg	Fresh water	
		Output	Emission	Pm-147	1.63			kBq	Air	
		Output	Emission	Po-210	0.297			kBq	Fresh water	
		Output	Emission	Po-210	0.65			kBq	Air	
		Output	Emission	Po-210	21.4			kBq	Air	
		Output	Emission	PO43-	0.0000421			kg	Sea water	
		Output	Emission	PO43-	0.128			kg	Fresh water	
		Output	Emission	Propane	0.00415			kg	Air	
		Output	Emission	Propane	0.0386			kg	Air	
		Output	Emission	Propene	0.000564			kg	Air	
		Output	Emission	Propene	0.00102			kg	Air	
		Output	Emission	Propionic acid	0.000242			kg	Air	
		Output	Emission	Propionic aldehyde	0.000000068			kg	Air	
		Output	Emission	Pt	0.000000188			kg	Air	
		Output	Emission	Pu alpha	0.192			kBq	Air	
		Output	Emission	Pu alpha	31.6			kBq	Sea water	
		Output	Emission	Pu-238	0.00000703			kBq	Air	
		Output	Emission	Pu-241 beta	5.27			kBq	Air	
		Output	Emission	Pu-241 beta	786			kBq	Sea water	
		Output	Emission	Ra-224	0.0691			kBq	Fresh water	
		Output	Emission	Ra-224	0.538			kBq	Sea water	
		Output	Emission	Ra-226	0.0917			kBq	Air	
		Output	Emission	Ra-226	1.08			kBq	Sea water	
		Output	Emission	Ra-226	147000			kBq	Fresh water	
		Output	Emission	Ra-226	60.2			kBq	Air	

		Output	Emission	Ra-228	0.0497			kBq	Air	
		Output	Emission	Ra-228	0.138			kBq	Fresh water	
		Output	Emission	Ra-228	1.08			kBq	Sea water	
		Output	Emission	Rb	0.0000164			kg	Fresh water	
		Output	Emission	Rb	0.000108			kg	Sea water	
		Output	Emission	Rn-220	4.22			kBq	Air	
		Output	Emission	Rn-222	4640000			kBq	Air	
		Output	Emission	Rn-222	9.74			kBq	Air	
		Output	Emission	Rn-222 (long term)	427000000			kBq	Air	
		Output	Emission	Ru-103	0.000032			kBq	Air	
		Output	Emission	Ru-103	0.0118			kBq	Fresh water	
		Output	Emission	Ru-106	19.2			kBq	Air	
		Output	Emission	Ru-106	1920			kBq	Sea water	
		Output	Emission	S	0.0132			kg	Ground	
		Output	Emission	S2-	0.000136			kg	Sea water	
		Output	Emission	S2-	0.00101			kg	Fresh water	
		Output	Emission	Salt	0.874			kg	Fresh water	
		Output	Emission	Sb	0.0000245			kg	Air	
		Output	Emission	Sb	0.0000364			kg	Fresh water	
		Output	Emission	Sb	4.19E-08			kg	Air	
		Output	Emission	Sb-122	0.035			kBq	Fresh water	
		Output	Emission	Sb-124	0.000879			kBq	Air	
		Output	Emission	Sb-124	5.71			kBq	Fresh water	
		Output	Emission	Sb-125	0.000103			kBq	Air	
		Output	Emission	Sb-125	0.287			kBq	Fresh water	
		Output	Emission	Sc	0.000000151			kg	Air	
		Output	Emission	Sc	0.0000103			kg	Air	
		Output	Emission	Se	0.00000243			kg	Air	
		Output	Emission	Se	0.00000356			kg	Sea water	
		Output	Emission	Se	0.000335			kg	Air	
		Output	Emission	Se	0.00037			kg	Air	
		Output	Emission	Se	0.0351			kg	Fresh water	
		Output	Emission	Si	0.000072			kg	Air	
		Output	Emission	Si	0.000797			kg	Fresh water	
		Output	Emission	Si	0.000954			kg	Air	
		Output	Emission	Si	0.131			kg	Air	
		Output	Emission	Sn	0.0000202			kg	Air	
		Output	Emission	Sn	0.000068			kg	Fresh water	
		Output	Emission	Sn	7.68E-08			kg	Air	
		Output	Emission	SO2	0.931			kg	Air	
		Output	Emission	SO2	11.2			kg	Air	
		Output	Emission	SO2	13			kg	Air	
		Output	Emission	SO32-	0.00118			kg	Fresh water	
		Output	Emission	SO42-	0.0966			kg	Sea water	
		Output	Emission	SO42-	490			kg	Fresh water	
		Output	Emission	Sr	0.00000768			kg	Air	
		Output	Emission	Sr	0.000845			kg	Air	
		Output	Emission	Sr	0.0328			kg	Fresh water	
		Output	Emission	Sr	0.0648			kg	Sea water	
		Output	Emission	Sr-89	0.00568			kBq	Air	
		Output	Emission	Sr-89	0.0804			kBq	Fresh water	
		Output	Emission	Sr-90	0.0296			kBq	Fresh water	
		Output	Emission	Sr-90	3.17			kBq	Air	
		Output	Emission	Sr-90	384			kBq	Sea water	
		Output	Emission	Suspended solids	1.03			kg	Sea water	
		Output	Emission	Suspended solids	18.2			kg	Fresh water	
		Output	Emission	Tc-99	0.000134			kBq	Air	
		Output	Emission	Tc-99	201			kBq	Sea water	
		Output	Emission	Tc-99m	0.0175			kBq	Fresh water	
		Output	Emission	Te-123	0.00148			kBq	Fresh water	
		Output	Emission	Te-123m	0.0144			kBq	Air	
		Output	Emission	Te-132	0.000606			kBq	Fresh water	
		Output	Emission	Tetrachloroethene	0.000000053			kg	Fresh water	
		Output	Emission	Tetrachloromethane	0.0000122			kg	Air	
		Output	Emission	Tetrachloromethane	8.09E-08			kg	Fresh water	

	Output	Emission	Tetrafluoromethane	0.00187			kg	Air	
	Output	Emission	Th	0.000000151			kg	Air	
	Output	Emission	Th	0.0000183			kg	Air	
	Output	Emission	Th-228	0.042			kBq	Air	
	Output	Emission	Th-228	0.276			kBq	Fresh water	
	Output	Emission	Th-228	2.15			kBq	Sea water	
	Output	Emission	Th-230	21.4			kBq	Air	
	Output	Emission	Th-230	5560			kBq	Fresh water	
	Output	Emission	Th-232	0.0267			kBq	Air	
	Output	Emission	Th-232	0.0694			kBq	Fresh water	
	Output	Emission	Th-234	1.92			kBq	Air	
	Output	Emission	Th-234	35.9			kBq	Fresh water	
	Output	Emission	Ti	0.0000233			kg	Air	
	Output	Emission	Ti	0.00312			kg	Air	
	Output	Emission	Ti	0.138			kg	Fresh water	
	Output	Emission	Tl	0.00000842			kg	Air	
	Output	Emission	Tl	3.84E-08			kg	Air	
	Output	Emission	Toluene	0.000216			kg	Fresh water	
	Output	Emission	Toluene	0.00116			kg	Sea water	
	Output	Emission	Toluene	0.00288			kg	Air	
	Output	Emission	Toluene	0.00468			kg	Air	
	Output	Emission	Total organic carbon	0.00674			kg	Fresh water	
	Output	Emission	Total organic carbon	0.056			kg	Sea water	
	Output	Emission	Total organic carbon	0.0827			kg	Sea water	
	Output	Emission	Total organic carbon	0.882			kg	Fresh water	
	Output	Emission	Tributyltin	0.0000571			kg	Sea water	
	Output	Emission	Trichloroethene	0.00000335			kg	Fresh water	
	Output	Emission	Trichloromethane	0.00000103			kg	Air	
	Output	Emission	Trichloromethane	0.0000123			kg	Fresh water	
	Output	Emission	Triethylene glycol	0.00114			kg	Sea water	
	Output	Emission	Triethylene glycol	0.00457			kg	Fresh water	
	Output	Emission	U	0.0000208			kg	Air	
	Output	Emission	U	7.68E-08			kg	Air	
	Output	Emission	U alpha	2320			kBq	Fresh water	
	Output	Emission	U alpha	6.62			kBq	Sea water	
	Output	Emission	U alpha	68.8			kBq	Air	
	Output	Emission	U-234	23			kBq	Air	
	Output	Emission	U-234	47.5			kBq	Fresh water	
	Output	Emission	U-235	1.12			kBq	Air	
	Output	Emission	U-235	70.8			kBq	Fresh water	
	Output	Emission	U-238	0.0764			kBq	Air	
	Output	Emission	U-238	109			kBq	Fresh water	
	Output	Emission	U-238	22.7			kBq	Air	
	Output	Emission	V	0.00000341			kg	Sea water	
	Output	Emission	V	0.0000177			kg	Air	
	Output	Emission	V	0.0011			kg	Air	
	Output	Emission	V	0.00571			kg	Air	
	Output	Emission	V	0.0662			kg	Fresh water	
	Output	Emission	W	0.00009			kg	Fresh water	
	Output	Emission	Vinyl chloride	0.000000015			kg	Fresh water	
	Output	Emission	Vinyl chloride	0.00000636			kg	Air	
	Output	Emission	VOC	0.000484			kg	Fresh water	
	Output	Emission	VOC	0.00377			kg	Sea water	
	Output	Emission	Xe-121m	668			kBq	Air	
	Output	Emission	Xe-133	214000			kBq	Air	
	Output	Emission	Xe-133m	106			kBq	Air	
	Output	Emission	Xe-135	36100			kBq	Air	
	Output	Emission	Xe-135m	3350			kBq	Air	
	Output	Emission	Xe-137	81.3			kBq	Air	
	Output	Emission	Xe-138	907			kBq	Air	
	Output	Emission	Xylene	0.000179			kg	Fresh water	
	Output	Emission	Xylene	0.00101			kg	Sea water	
	Output	Emission	Xylol	0.00285			kg	Air	
	Output	Emission	Xylol	0.0176			kg	Air	
	Output	Emission	Y-90	0.00439			kBq	Fresh water	

	Output	Emission	Zn	0.0000343			kg	Sea water	
	Output	Emission	Zn	0.000346			kg	Ground	
	Output	Emission	Zn	0.00167			kg	Air	
	Output	Emission	Zn	0.00264			kg	Air	
	Output	Emission	Zn	0.00282			kg	Air	
	Output	Emission	Zn	0.0438			kg	Fresh water	
	Output	Emission	Zn-65	0.0138			kBq	Air	
	Output	Emission	Zn-65	2.47			kBq	Fresh water	
	Output	Emission	Zr	0.00000186			kg	Air	
	Output	Emission	Zr-95	0.000208			kBq	Air	
	Output	Emission	Zr-95	0.00484			kBq	Fresh water	
	Output	Emission	Zr-95	16.3			kBq	Sea water	
	Output	Product	Electricity	1			TJ	Technosphere	
	Output	Residue	Hazardous waste	2.86			kg	Technosphere	
	Output	Residue	Highly radioactive waste	0.00849			kg	Technosphere	
	Output	Residue	Inert waste deposit	1290			kg	Technosphere	
	Output	Residue	Low radioactive waste	0.00134			kg	Technosphere	
	Output	Residue	Medium and low radioactive waste	0.0164			kg	Technosphere	
	Output	Residue	Reactive waste deposit	1.59			kg	Technosphere	
	Output	Residue	Waste deposit	225			kg	Technosphere	
	Output	Residue	Waste in land farming	2.3			kg	Technosphere	
	Output	Residue	Waste to incineration	1.17			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www.energieforschung.ch. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their lifecycles. The results can be used in lifecycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans.
Detailed Purpose	ETH:s aim of this LCI was to describe the averag situation in UCPTE concerning electricity generation with nuclear power. Material and energyware needs, emissions and solid waste have been inventoried in all steps of the nuclear fuel cycle regarding construction, operation and demolition phases all through the lifecycle.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Data reported here is supposed to be representative for nuclear power in the UCPTE countries in 1994.

About Data	The exactitude concerning radioactive emissions to air and water is ±50%. Data concerning construction of UCPTE nuclear power is probably slightly overestimated since a major part of French and German nuclear power plants have a capacity of about 1300 MWe. Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided). Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of metadata describing the ETH study has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut

SPINE LCI dataset: Nuclear power plant with support systems

Administrative	
Finished	Y
Date Completed	1996-12-01
Copyright	
Availability	Public

Technical System	
Name	Nuclear power plant with support systems
Functional Unit	Net production of 1 kWh electricity
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the production of 1 kWh electricity.
Process Type	Cradle to gate
Site	Forsmark nuclear power plant
Sector	Grid electricity and district heat
Owner	Forsmark nuclear power plant
Technical system description	The studied system include the *nuclear fuel chain and the operation and maintenance of the nuclear power plant*. The fuel chain include: extraction in mine, conversion, enrichment, fuel production, handling of used nuclear fuel and waste and final storage. Production of materials, chemicals and electricity and transports, used in association with the fuel chain and the operation and maintenance of the plant are included.

	To represent the nuclear power plants of Vattenfall, Forsmark has been studied. Forsmark has 3 boiling-water reactors (BWR). Forsmark 3 has been chosen for detailed study. *Technical data* for the reactors at Forsmark: Forsmark 1: Effect, net: 970 MW; Average annual production: 6600 GWh; operation time: 6800 hours/year. Forsmark 2: Effect, net: 970 MW; Average annual production: 6600 GWh; operation time: 6800 hours/year. Forsmark 3: Effect, net: 1158 MW; Average annual production: 7600 GWh; operation time: 6565 hours/year. ***Uranium extraction and uranium plant*** The uranium ore is extracted in an open cast mine in Key Lake, Canada, with a content of U3O8 of 2,22%. After the mining, the ore is transported to a uranium plant where uranium concentrate is produced from the uranium ore. The plant is located 1,5 km from the mine. Large amounts of chemicals e.g. sulphuric acid and ammonia are used in the process. The sulphuric acid is produced in connection with the plant. The uranium concentrate is transported in barrels on trucks to the conversion plant, located 4000 km away. ***Conversion*** At conversion the uranium concentrate is converted to uraniumhexaflouride (HF6) through a reaction with flouride hydrogen and flouride. The conversion takes place in two steps and the uranium is transported 600 km by truck between the two steps. After the conversion, the uraniumhexaflouride is transported to France and Holland via truck and boat and railway for enrichment. ***Enrichment*** At enrichment, the share of the fissionable isotope uranium-235 are increased from 0,7% to 3% (the rest of the uranium is uranium-238). Two different processes can be used; the centrifugal method and the gaseous diffusion method. The studied system concern uranium where 60 % is assumed to be produced with the centrifugal method and 40 % with the gaseous diffusion method. Enrichment according to the gaseous diffusion process takes place in France. The process is very energy demanding; 3-4% of the energy produced, are used in the process. French average electricity mix have been used in the calculations. 100% nuclear power could be used in the calculations, since four 900 MW nuclear power reactors have been built in connection with the enrichment plant. Enrichment according to the centrifugal method are assumed to take place in Holland. The process is not as energy demanding as the gaseous diffusion process; 0,1 % of the energy produced, is used in the process. Vattenfall also buys enrichment services according to this process from England, Germany and Russia. ***Fuel production*** In the fuel plant uraniumhexaflouride is converted to uranium dioxide in powder form. The powder is pressed to 1 cm long pellets, that are inserted into rods manufactured of zirconium alloy. The rods are mounted together in a sheet-metal box. Control rods are also manufactured in the fuel plant. These mainly consist of stainless steel. The fuel is transported to the nuclear power plant. ***Operation and maintenance*** Medium active waste and some low active waste from the operation and maintenance of the plant are transported to SFR (Final storage for low and medium active radioactive waste), situated in a mountain room below sea level at Forsmark. The transport to SFR takes place with special vehicles from Forsmark. ***Handling of used nuclear fuel and waste and final storage*** Every year, 20 % of the fuel is replaced. The used nuclear fuel are taken to CLAB (Central storage for used fuel) where it is stored (mellanlagras). The used fuel is handled in special transport containers. The weight of these have been accounted for as a standard addition of 10% to the transport. After 40 years of storage, the used fuel are encapsulated in CLAB2 and final stored. The encapsulation are planned to take place in connection to CLAB. The capsules are assumed to have double walls of steel and copper. The inner part has a 5 cm thick wall of steel with a 5 cm thick copper coating. The capsule will possibly also contain some sort of filling material. Crushed glass are assumed. The final storage will be closed about 40 years after the last nuclear reactor have been taken out of use.

System Boundaries

Nature Boundary	All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).

Time Boundary	The nuclear power plant are assumed to have an operation time of 40 years. Sensitivity analysis is performed after 25 years, since this life-time often are mentioned in the political debate. The final storage for used nuclear fuel is in this study considered to be closed after 40 years after the nuclear power plant have been taken out of use. Any emissions from the closed final storage are not included.
Geographical Boundary	The nuclear power plant is located in Forsmark. The mining of uranium ore takes place in Key Lake, Canada. The enrichment is located in Holland and France and the fuel production in Sweden.

Other Boundaries	The studied system include the *nuclear fuel chain and the operation and maintenance of the nuclear power plant*. Calculations of building and demolition of the plant has been performed but are not included in this system. ***Sub-systems included in the system:*** • Use of resources and emissions associated with reinvestments and reconstruction. Concrete constructions and buildings are however not considered to need renewal during the lifetime of the power station. • The entire fuel chain have been studied, from fuel production to waste handling. • The building and demolition of the Swedish plants for storage of operation waste, and used fuel are included e.g. SFR(Final storage for low and medium active radioactive waste), CLAB(Central storage for used fuel), encapsulation station and deep storage. • Energy and raw material use for the production of the materials in the capsules are included. • Electricity used in the nuclear power plant, to run supply water and cooling water pumps is included. Diesel oil used as reserve- and backup power for the plant are included. • Known use of chemicals are accounted for. In the cases where it was possible to obtain data, resource use and emissions for the production are included. • Use of resources and emissions to air, from production of the electricity that is used in the life cycles. • Energy use and emissions for the production of oil for the studied manufacturing processes and transports. ***Sub-systems excluded from the system:*** • The building of plants for extraction, conversion and enrichment of uranium and manufacture of fuel are not included since the serve several users. • Emissions and energy use in the encapsulation plant. • Environmental influence from major accidents is not included, a number of risk studies have already been performed. • Equipment after the power station transformer. • Waste and rest products are transported to final waste. Operation and chemical and biological decomposing processes (nedbrytningsprocesser) in the final waste have not been considered. • The risk of major accidents and rare breakdowns and environmental consequences from these. • Work environment. • Environmental loads caused by the operation personnel.
Allocations	The *50/50 method* has been applied throughout the calculations. The method is described in ´Nordic Guidelines on Life-Cycle Assessment´, Nord 1995:20, The Nordic Council, Stockholm. Copper used for encapsulation of used nuclear fuel are assumed to be 100% virgin source.
Systems Expansions	

Flow Data

General Activity QMetaData	
Date Conceived	
Data Type	Derived, unspecified
Represents	Average nuclear power in the UCPTE countries.
Method	An LCA calculation of fuel production, operation and maintenance and handling of rest products for a nuclear power plant.
Literature Reference	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes:	Input	Natural resource	Area	.000002			m2	Ground	
Notes: The amounts are allocated.	Input	Natural resource	Bauxite	.086700			mg	Ground	
Notes:	Input	Natural resource	Bio fuel	.000002			kWh	Other	
Notes:	Input	Natural resource	Coal	.004280			kWh	Other	
Notes:	Input	Natural resource	Copper ore	2.070000			g	Ground	
Notes: The amounts are allocated.	Input	Natural resource	Iron ore	.034600			g	Ground	
Notes: The amounts are allocated.	Input	Natural resource	Lead ore	.006630			g	Ground	
Notes:	Input	Natural resource	Natural gas	.000922			kWh	Other	
Notes: Fuel for production of 1 kWh electricity in the power plant.	Input	Natural resource	Uranium ore	1.240000			g	Ground	
Notes:	Input	Natural resource	Wood	.004790			g	Ground	
Notes: Have not been traced back to the cradle	Input	Refined resource	Ammonia	.015300			g	Technosphere	
Notes: Electricity produced by water power.	Input	Refined resource	Electricity	.003240			kWh	Technosphere	
Notes: Electricity produced by nuclear power.	Input	Refined resource	Electricity	.010200			kWh	Technosphere	
Notes: Have not been traced back to the cradle	Input	Refined resource	H2SO4	.166000			g	Technosphere	
Notes: The figure includes oil, gasoline and diesel	Input	Refined resource	Heavy oil	.003520			kWh	Technosphere	
Notes: Have not been traced back to the cradle	Input	Refined resource	NaOH	.004280			g	Technosphere	
Notes: Have not been traced back to the cradle	Input	Refined resource	Nitric acid	.007810			g	Technosphere	
Notes: Gaps of data for e.g. the manufacture of copper, lead and cement.	Output	Emission	CO	.003720			g	Air	
Notes:	Output	Emission	CO2	2.550000			g	Air	
Notes: Reports the total HC. Data gaps for e.g. manufacture of copper, lead and cement.	Output	Emission	HC	.001020			g	Air	
Notes:	Output	Emission	NOx	.015800			g	Air	
Notes: There are gaps of data for e.g. manufacture of copper, lead, cement and lubricating oil.	Output	Emission	N-tot	.000327			g	Water	
Notes: Gaps of data for e.g. manufacture of lubricating oil, explosives and personal transports.	Output	Emission	Particles	.007640			g	Air	
Notes:	Output	Emission	SO2	.013400			g	Air	
Notes:	Output	Product	Electricity	1.000000			kWh	Technosphere	
Notes:	Output	Residue	Building waste	.067800			g	Technosphere	
Notes:	Output	Residue	Highly active rad ac waste	.045300			g	Technosphere	

Notes:	Output	Residue	Low active rad ac waste	0.000000012			m3	Technosphere	
Notes:	Output	Residue	Low active rad ac waste	27.400000			ug	Technosphere	
Notes:	Output	Residue	Medium active rad ac waste	0.000000012			m3	Technosphere	
Notes:	Output	Residue	Other rest products	19.6			g	Technosphere	

About Inventory

Publication	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology
Intended User	The data can be used as a basi
General Purpose	• The work with life-cycle analysis are expected to *contribute to a reinforcement and structuring* of the environmental work within Vattenfall, and a deeper knowledge on the use of resources and emissions to the environment. • An LCA can *facilitate a need for reliable data for electricity production.* Electricity is used in the manufacture of almost every product, and data from an LCA can be used when conducting an LCA on products. • An LCA can *facilitate a choice between different techniques* for future electricity production. • An LCA can also help to *choose the most effective alternatives* to reduce the consumption of resources and environmental influence of the current electricity production system. • It is also possible to *compare* the environmental load for different alternatives of electricity production.
Detailed Purpose	To obtain a *reliable basis* to be able to perform life-cycle analyses of different types of electricity use, and to identify opportunities for improvements in the existing system. To identify data gaps and areas where the knowledge are poor.
Commissioner	- Vattenfall Elproduktion .
Practitioner	- Vattenfall Energisystem AB: Britt-Marie Brännström-Norberg Ulrika Dethlefsen Roland Johansson Caroline Setterwall Sofie Tunbrant .
Reviewer	- Thomas Ekvall, Chalmers Industriteknik (CIT) Gunnar Lindfors, Institutet för Vatten- och Luftvårdsforskning (IVL) Göran Finnveden, Institutet för Vatten- och Luftvårdsforskning (IVL)
Applicability	The analysis are based on data from plants that are chosen to make the analysis representative for the fuel production, operation and maintenance and handling of rest products of Vattenfall:s nuclear power plants. The data are reliable since specific plants have been studied. The consequence is however that the result is primarily valid for the studied plant. Thoroughly reliable data for every power source, requires life cycle analyses for a large number of power plants for every power source. Nuclear and water power are the base for Vattenfall:s electricity production system. The studied nuclear power plant, Forsmark, has 3 *boiling-water reactors (BWR).* Other reactors in Sweden are mainly of BWR-type, while most light-water reactors in the rest of the world are pressurised-water reactors (PWR). Transmission and distribution losses are not included. When the result is used to study different types of electricity use, these losses should be included. A rough estimate are that the distribution losses for a large industry customer are approximately 5% of the bought electricity, i.e. to obtain data for the use of electricity the data should be multiplied with 1,05. For an average household customer the transmission losses are approximately 10% of the bought electricity, i.e. the data should be multiplied with 1,10. The study concern *uranium extracted* from an open-cast mine in Canada. The influence of choosing another mine is not clear. A rough estimate are that the chosen mine represents a middle alternative - there are both better and worse mines.

	The study concerns uranium that is to *60 % enriched with the centrifugal method and to 40 % with the gaseous diffusion method*, which was representative for the acquisitions of uranium by Vattenfall in 1993. The choice of distribution between the two methods has a great influence on the energy use and therefore on the results. The study concerns *radioactive waste* that are stored and encapsulated at CLAB, which is characteristic for Vattenfall:s nuclear power and Swedish nuclear power, but not for nuclear power in other countries. The result would be significantly affected if the waste were handled in a different way. The complete study include building, operation and maintenance, and demolition of the power plant and fuel production and handling of rest products from the fuel. When the data is used for energy production in a life cycle analysis of a product or a system, that do not require expansion of the electricity production system, it however reasonable only to include fuel production, operation and maintenance and handling of rest products from the fuel. The other phases of the life cycle are the same independent on the electricity production.
About Data	The data that has been used are primarily from *Forsmark nuclear power plan*t. Forsmark has 3 boiling-water reactors (BWR). Forsmark 3 has been chosen for detailed study, because it is most recent built and it is also built with the strictest requirements. The *fuel production chain include uranium extraction from mine, uranium plant, conversion, enrichment and fuel production.* In the calculations actual values from 1993 have been used, to account for the use of resources and emissions. The choice of plants have been made from the plants type-value ("an average plant") and the possibility to obtain data. The mine, uranium plant and conversion plant are located in Canada. Enrichment takes place in France and Holland and fuel production in Sweden. Relevant data for transports, extraction and production of metals and chemicals, and manufacture and work on important components were hard to obtain. Data from manufacturers and other reports and studies, primarily life cycle analyses have been used. Production of material and transports are considered with current technology. Swedish standard values have been used to calculate fuel use and emissions from transports. Transport distances are specific for the operation of the plant. *The parameters that are presented* are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate. The mine chosen as example in the analysis is Key Lake in Canada. The motive is that the deliveries in 1993 were biggest from this mine. In 1993 40 % of the uranium used in VattenfallÆs nuclear power plants came from Key Lake mine in Canada, 24 % from Olympic Dam mine in Australia, and 36 % from Novouralsk in Russia. Key Lake is also probably in a middle position concerning environmental influence of the three suppliers. The uranium from Novoralsk are considered to give the lowest environmental effects. It is not clear, through allocation reasons how Key Lake compares to Olympic Dam. At enrichment, 60 % of the uranium is assumed to be produced with the centrifugal method and 40 % with the gaseous diffusion method. Enrichment according to the *gaseous diffusion process* takes place in France. The process is very energy demanding; 3-4% of the energy produced, are used in the process. French average electricity mix have been used in the calculations. 100% nuclear power could be used in the calculations, since four 900 MW nuclear power reactors have been built in connection with the enrichment plant. The calculations of emissions for electricity production for enrichment in France are therefore very conservative. Enrichment according to the *centrifugal method* are assumed to take place in Holland. The process is not as energy demanding as the gaseous diffusion process; 0,1 % of the energy produced, is used in the process. Vattenfall also buys enrichment services according to this process from England, Germany and Russia. The total volume of *low and medium active radioactive operation waste* from a nuclear power that has operated for 40 years is calculated to be 70000m3. It consists e.g. of

	protective clothing, tools and replaced parts used in the active area of the plant, and equipment to purify the process water. *Medium active waste and some low active waste* are transported to SFR (Final storage for low and medium active radioactive waste), situated in a mountain room below sea level at Forsmark. Actual average values from SFR have been used in the analysis. The transport to SFR takes place with special vehicles from Forsmark. The transports demands energy and causes some emissions from combustion of oil products. Every year, *20 % of the fuel is replaced*. The used nuclear fuel are taken to CLAB (Central storage for used fuel) where it is stored (mellanlagras). Actual average values from CLAB have been used in the analysis. After 40 years of storage, the used fuel are encapsulated in CLAB2 and final stored. The encapsulation are planned to take place in connection to CLAB. The used fuel is handled in special transport containers. The weight of these have been accounted for as a standard addition of 10% to the transport. Data for material and transport needs for *plants for the handling of nuclear waste* are derived from SKB concept for deep storage. These are based on the fact that the Swedish nuclear power program will be ended in 2010, equivalent to 30 years operation with current operation. In this analysis, SKB:s calculations for 25 years operation have been used. The environmental influence of these plants for used nuclear fuel will then be overestimated. Use of resources and emissions associated with *reinvestments and reconstruction* are included. They are generally assumed to give an addition of 1 % per year of the use of resources and emissions at the building phase. Concrete constructions and buildings are however not considered to need renewal during the lifetime of the power station. The following data for Forsmark 3 has been used in the calculations (tonnes per year under 40 years) Steel: 22,80 Copper: 0,75 Lead: 6,23 Aluminium: 1,70 Titanium: 0,05 PVC: 5,82 For electricity used in the manufacture of materials and fuels, *average electricity* for the respective countries, distributed on the different electricity production alternatives have been used. The following *degrees of efficiencies* have been used to calculate the fuel used in the electricity production. The values are standard values for existing power plants. New modern plants often have higher degrees of efficiencies. The values are calculated from the effective heat value in the used fuels and the energy content in the steam produced in a nuclear power plant. • Coal condensing: 40% • Oil condensing: 40% • Natural gas condensing/combination: 40% • Gas turbine: 25% • Combined heat and power plant(irrespective of fuel) 30% (for electricity production) 85% (total for electricity and heat production) • Water power: are not recalculated, are accounted for as kWh electricity • Nuclear power: 33%, are however not recalculated, but accounted for as kWh electricity or gram natural uranium.
Notes	Mining of uranium ore gives a local environmental effect during extraction. The water recipient are influenced through emission of heated cooling water from the power plant.

SPINE LCI dataset: OECD Europe, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	OECD Europe, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	OECD Europe
Sector	Energyware
Owner	OECD Europe
Technical system description	The generation of electricity with different power generating systems in the OECD Europe during the year 1998. OECD (Organisation for Economic Co-Operation and Development) Europe includes Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland and United Kingdom.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	Average nuclear power in the UCPTE countries.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Represents: Wind	Input	Refined resource	Electricity	11228			GWh	Technosphere	
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	1468			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	207542			GWh	Technosphere	

Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	330258			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	401740			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	45015			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	5012			GWh	Technosphere	
Represents: Hydro power, pumped storage excluded	Input	Refined resource	Electricity	505074			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	590			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	590653			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	70			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	907139			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	3005789			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998

	Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: OECD North America, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	OECD North America, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	OECD North America
Sector	Energyware
Owner	OECD North America
Technical system description	The generation of electricity with different power generating systems in the OECD North America during the year 1998. OECD (Organisation for Economic Co-Operation and Development) North America includes Canada, Mexico and United States.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	OECD electricity generation mix
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	155452			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	1976125			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	21026			GWh	Technosphere	
Represents: liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	266609			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	2993			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	32			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	607797			GWh	Technosphere	
Represents: Hydro power, pumped storage excluded	Input	Refined resource	Electricity	649713			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	72210			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	794900			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	893			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	4547750			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. --- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden ---
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow.

	When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: OECD Pacific, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	OECD Pacific, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation

Site	OECD Pacific
Sector	Energyware
Owner	OECD Pacific
Technical system description	The generation of electricity with different power generating systems in the OECD Pacific during the year 1998. OECD (Organisation for Economic Co-Operation and Development) Pacific includes Australia, Japan, Korea and New Zealand.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	OECD electricity generation mix
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	12			GWh	Technosphere	
Represents: Hydro power, pumped storage excluded Notes: The value have been corrected after publishing in SPINE@CPM. See Inventory Notes for a description.	Input	Refined resource	Electricity	136831			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	186510			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	25311			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	270768			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	404475			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	422032			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	51352			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	6009			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	67			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	71			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	1503438			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	--- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 22 October 2001: <<< Changes made by Ann-Christin Pålsson, CPM: The electricity production by hydro power have been corrected from 136831149327 GWh to 136

	831 GWh according to the original report. The error was identified and reported by Gunnar Mattson, ABB Corporate Research.

SPINE LCI dataset: OECD total, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	OECD total, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	OECD countries
Sector	Energyware
Owner	OECD countries
Technical system description	The generation of electricity with different power generating systems in the OECD countries during the year 1998. OECD (Organisation for Economic Co-Operation and Development) includes Australia, Austria, Belgium, Canada, Czech Republic, Denmark Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	OECD electricity generation mix
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Represents: Solar	Input	Refined resource	Electricity	1034			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	1280305			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	1291618			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	142536			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	14288			GWh	Technosphere	
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	1480			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	2124071			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	2971253			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	32047			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	537062			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	622			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	660661			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	9056977			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. --- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden ---
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998

	European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Oil condensing power plant with support systems

Administrative	
Finished	Y
Date Completed	1996-12-01
Copyright	
Availability	Public

Technical System	
Name	Oil condensing power plant with support systems
Functional Unit	Net production of 1 kWh electricity
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the production of 1 kWh electricity.
Process Type	Cradle to gate
Site	Stenungsund oil condensing power plant
Sector	Grid electricity and district heat
Owner	Stenungsund oil condensing power plant
Technical system description	The studied system include *fuel production and operation and maintenance of a oil condensing power plant.* To represent the electricity production of Vattenfall in oil condensing power plants, Stenungsund, is studied. The plant is used for reserve power. The power plant is assumed to operate on fuel oil 1 (Eo1) produced from crude oil from the Norwegian continental-shelf. The fuel has a sulphur content of 0,1 %. The

	plant has a harbour, where oil is landed via pipe-line to an oil storage. Production of materials, chemicals and electricty and transports, used in association with the fuel chain and the operation and maintenance of the plant are included. *The fuel production* include drilling and extraction of crude oil, maintenance and reinvestments of the oil platforms, transport to the refinery in Mongstad, Norway, where the oil is refined to fuel oil 1 and transport from the refinery to the power plant. Coal condensing power plants are generally fired with fuel oil, Eo5, Eo1 or WRD oil (wide range distillate). The sulphur content of the oil is below 0,2% and 0,1% respectively, equivalent to 50 and 25 mg S/MJ. The Eo1 oil is refined from crude oil extracted in the North sea, while the origin of the heavy fuel oil (Eo2 and Eo5) varies. *Technical data* for the studied power plant: Annual time of use (recalculated as operation time at full effect) (hours): 1000 Supplied fuel effect (MW): 2100 Electricity effect, net (MW): 820 Assumed life-time (years): 60 Electricity production (net) during 60 years (TWh): 49,2

System Boundaries

Nature Boundary	The analysis starts with *extraction of crude oil.* All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The plant is assumed to have an operation time of 60 years.
Geographical Boundary	The plant is located i Stenungsund. The fuel used in the plant, are refined from crude oil from the Norwegian continental-shelf. The oil is transported by tanker to the refinery in Mongstad (Norway), and then as fuel oil 1 with tanker to the power plant.
Other Boundaries	The studied system included *fuel production and operation and maintenance of a oil condensing power plant.* Calculations of building and demolition have been performed but are not included in this system. ***Sub-systems included in the system:*** • The fuel chain include extraction of crude oil in the North sea, transport of crude oil, refining, oil transport to the power plant and combustion. • Transports in association with operation and maintenance of the power plant. • Reinvestments for the plant except buildings, transformers and cables • Known use of chemicals are accounted for. In the cases where it was possible to obtain data, resource use and emissions for the production are included. • Use of resources and emissions to air, from production of the electricity that is used in the life cycles. • Energy use and emissions for the production of oil for the studied manufacturing processes and transports. ***Sub-systems excluded from the system:*** • Reinvestments of buildings, transformers and cables, since the plant is only used for reserve power. • The prospecting for oil, building and demolition of factories, oil platforms, oil tankers and oil refineries. • Equipment after the power station transformer are not included.

	• Waste and rest products are transported to final waste. Operation and chemical and biological decomposing processes (nedbrytningsprocesser) in the final waste have not been considered. • The risk of major accidents and rare breakdowns and environmental consequences from these. • Work environment. • Environmental loads caused by the operation personnel.
Allocations	The *50/50 method* has been applied throughout the calculations. The method is described in ''Nordic Guidelines on Life-Cycle Assessment'', Nord 1995:20, The Nordic Council, Stockholm. Crude oil for production of fuel to the plant are assumed to be extracted together with natural gas. Data were obtained from Kristin Keiserås Bakkane, Novatech a.s. ''Life Cycle Data for Norwegian Oil and Gas'', that were based on the production at Norwegian oil fields in 1991. An average value for the extracted energy oil (78,6%) and gas (21,3%) for the year in question were used. In reality the distribution between extracted energy for oil and gas respectively, varies. Data has been allocated according to the average value, *i.e. 78,6% of emissions and use of resources are allocated to the crude oil production.* Equipment, use of resources and emissions used only in association with the extraction of one energyware are allocated 100% to that. The oil is assumed to be refined in Mongstad, Norway. Data for production of fuel oil 1 have been obtained from Statoil. The allocation between the different products in the refinery are not known.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Unspecified, expert outspoke
Represents	OECD electricity generation mix
Method	An LCA calculation of fuel production, operation and maintenance of an oil condensing power plant.
Literature Reference	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', in Swedish, Vattenfall AB
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate. The extraction of oil, including transport are responsible for a large share of the NOx-emissions. The combustion (after flue gas cleaning) contributes to the largest emissions of SO2 and CO2. The combustion also gives the largest NOx-emissions.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Land for extraction of raw materials, final waste is not included.	Input	Natural resource	Area	.000110			m2	Ground	
	Input	Natural resource	Bauxite	.006070			g	Ground	
	Input	Natural resource	Bio fuel	.000004			kWh	Other	
	Input	Natural resource	Coal	.000294			kWh	Other	
	Input	Natural resource	Copper ore	.000697			g	Ground	
Notes: Fuel used for the operation of the power plant.	Input	Natural resource	Heavy oil	2.560000			kWh	Ground	
	Input	Natural resource	Iron ore	.063900			g	Ground	
	Input	Natural resource	Natural gas	.023300			kWh	Other	
Notes: Has not been traced back to the cradle.	Input	Refined resource	Ammonia	.000609			g	Technosphere	

Notes: Electricity produced by nuclear power. To produce 1 kWh electricity in a nuclear power plant, 1,24 gram uranium ore is used.	Input	Refined resource	Electricity	.000039			kWh	Technosphere	
Notes: Electricity produced by water power.	Input	Refined resource	Electricity	.003660			kWh	Technosphere	
Notes: There are big data gaps	Input	Refined resource	Heavy oil	.095400			kWh	Technosphere	
Notes: Has not been traced back to the cradle.	Input	Refined resource	NaOH	.033400			g	Technosphere	
Notes: There are data gaps e.g. for manufacture of copper and cement	Output	Emission	CO	.160000			g	Air	
	Output	Emission	CO2	714.000000			g	Air	
Notes: Includes emissions from the oil storage. Data gaps for e.g. manufacture of copper and cement.	Output	Emission	HC	.405000			g	Air	
	Output	Emission	NOx	.646000			g	Air	
Notes: There are data gaps for e.g. manufacture of copper, cement and lubricating oil.	Output	Emission	N-tot	.000137			g	Water	
Notes: There are data gaps e.g. manufacture of lubricating oil.	Output	Emission	Particles	.104000			g	Air	
	Output	Emission	SO2	.540000			g	Air	
	Output	Product	Electricity	1.000000			kWh	Technosphere	
	Output	Residue	Building waste	.018600			g	Technosphere	
Notes: There are big data gaps	Output	Residue	Other rest products	0.103			g	Technosphere	

About Inventory

Publication	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology
Intended User	The data can be used as a basi
General Purpose	• The work with life-cycle analysis are expected to *contribute to a reinforcement and structuring* of the environmental work within Vattenfall, and a deeper knowledge on the use of resources and emissions to the environment. • An LCA can *facilitate a need for reliable data for electricity production.* Electricity is used in the manufacture of almost every product, and data from an LCA can be used when conducting an LCA on products. • An LCA can *facilitate a choice between different techniques* for future electricity production. • An LCA can also help to *choose the most effective alternatives* to reduce the consumption of resources and environmental influence of the current electricity production system. • It is also possible to *compare* the environmental load for different alternatives of electricity production.
Detailed Purpose	To obtain a *reliable basis* to be able to perform life-cycle analyses of different types of electricity use, and to identify opportunities for improvements in the existing system. To identify data gaps and areas where the knowledge are poor.
Commissioner	- Vattenfall Elproduktion .
Practitioner	- Vattenfall Energisystem AB: Britt-Marie Brännström-Norberg Ulrika Dethlefsen Roland Johansson Caroline Setterwall Sofie Tunbrant .
Reviewer	- Thomas Ekvall, Chalmers Industriteknik (CIT) Gunnar Lindfors, Institutet för Vatten- och Luftvårdsforskning (IVL) Göran Finnveden, Institutet för Vatten- och Luftvårdsforskning (IVL)
Applicability	The studied system included fuel production and operation and maintenance of a oil condensing power plant. The analysis are based on data from a plant that are chosen to make the analysis *representative for operation and maintenance of Vattenfall:s oil condensing plants.* The oil condensing plants are used as *reserve power* and

	primarily at transient needs. The data are reliable since a specific plant have been studied. The consequence is however that the result is primarily valid for the studied plant. Thoroughly reliable data for every power source, requires life cycle analyses for a large number of power plants for every power source. The chosen plant, Stenungsund power plant is responsible for the larger share of Vattenfall:s electricity production in oil condensing power plants. The principle for how a condensing power plant works is not different today, compared to when the plant in Stenungsund was built in the late 1950s. The current boilers have however low-NOx combustion, that together with NOx-cleaning brings about lower emissions of NOx than calculated in this study. Transmission and distribution losses are not included. When the result is used to study different types of electricity use, these losses should be included. A rough estimate are that the distribution losses for a large industry customer are approximately 5% of the bought electricity, i.e. to obtain data for the use of electricity the data should be multiplied with 1,05. For an average household customer the transmission losses are approximately 10% of the bought electricity, i.e. the data should be multiplied with 1,10. Coal condensing power plants are *generally fired with fuel oil*, Eo5, Eo1 or WRD oil (wide range distillate). The sulphur content of the oil is below 0,2% and 0,1% respectively, equivalent to 50 and 25 mg S/MJ. The Eo1 oil is refined from crude oil extracted in the North sea, while the origin of the heavy fuel oil (Eo2 and Eo5) varies. The data used for *oil extraction* are representative for the Norwegian oil fields in use at present, but not for the extraction that will take place after the year 2000, when new modern fields are taken in operation. The complete study include building, operation and maintenance, and demolition of the power plant and fuel production. When the data is used for energy production in a life cycle analysis of a product or a system, that do not require expansion of the electricity production system, it however reasonable only to include fuel production and operation and maintenance. The other phases of the life cycle are the same independent on the electricity production.
About Data	The studied plant is an *existing power plant in Stenungsund*, that is used for reserve power. The power plant is assumed to operate on fuel oil 1 (Eo1) produced from crude oil from the Norwegian continental-shelf. The fuel has a sulphur content of 0,1 %. Data for the use of resources and energy for operation of the power stations are specific for the studied plant. Relevant data for transports, extraction and production of metals and chemicals, and manufacture and work on important components were hard to obtain. Data from manufacturers and other reports and studies, primarily life cycle analyses have been used. Production of material and transports are considered with current technology. Swedish standard values have been used to calculate fuel use and emissions from transports. Transport distances are specific for the operation of the plant. *The parameters that are presented* are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate. Data for *extraction of crude oil* were obtained from Kristin KeiserÕs Bakkane, Novatech a.s. "Life Cycle Data for Norwegian Oil and Gas", that were based on the production at Norwegian oil fields in 1991. Use of resources and emissions associated with *reinvestments and reconstruction* are generally assumed to give an addition of 0,5% per year of the use of resources and emissions at the building phase. Buildings, transformers and cables are however not considered to need renewal during the lifetime of the power station. The low level on reinvestments is explained by the fact that the plant is only used for reserve power and therefore proportionately little. The following data has been used (tonnes per year during 60 years): Steel: 3,0 Copper: 0,01

	Aluminium phosphate: 65,1 (of which aluminium: 5,95) Ammonia: 0,50 Sodium hydroxide: 27,4 Hydrochloric acid: 2,60 Slaked lime: 57,5 Transformer oil: 4,05 The emissions from operation of the power plant have been calculated with the following *emission factors*: NOx 50mg/MJ fuel, 6,61e-1 g/kWh electricity SO2 50mg/MJ fuel, 6,61e-1 g/kWh electricity CO 15 mg/MJ fuel, 1,38e-1 g/kWh electricity Particles 10 mg/MJ fuel, 9,20e-2 g/kWh electricity HC (from the power plant) 4 mg/MJ fuel, 3,71e-2 g/kWh electricity HC (from the oil storage) --mg/MJ fuel, 3,70e-3 g/kWh electricity CO2 74000 mg/MJ fuel, 682 g/kWh electricity For electricity used in the manufacture of materials and fuels, *average electricity* for the respective countries distributed on the different electricity production alternatives have been used. The following degrees of efficiencies have been used to calculate the fuel used in the electricity production. The values are standard values for existing power plants. New modern plants have often higher degrees of efficiencies. The values are calculated from the effective heat value in the used fuels and the energy content in the steam produced in a nuclear power plant. • Coal condensing: 40% • Oil condensing: 40% • Natural gas condensing/combination: 40% • Gas turbine: 25% • Combined heat and power plant(irrespective of fuel) 30% (for electricity production) 85% (total for electricity and heat production) • Water power: are not recalculated, are accounted for as kWh electricity • Nuclear power: 33%, are however not recalculated, but accounted for as kWh electricity or gram natural uranium.
Notes	

SPINE LCI dataset: Oil electricity energy system, EPD-version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Oil electricity energy system, EPD-version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.

Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures are based on data from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996 and adapted to the demands of the EPD-guidelines (Environmental Product Declaration guidelines in Sweden). -- Brief description -- The phases inventoried in ETH's life cycle stydy of electricity generation with oil are: exploration, extraction (onshore and offshore), transports, refinery, regional distribution and power plant operation. The average situation in the UCPTE* region in 1994 concerning the origin of the oil, transports of different kinds (Swiss conditions), refinery processes, distribution, power plant operation etc. is described. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle. -- Detailed description -- Exploration Drilling activities during exploration of crude oil (onshore and offshore) have been inventoried regarding use of energyware, drilling chemicals, water, steel and concrete (coating of drilling holes) and use of land/sea bed (not included in the figures, see other boundaries). Besides emissions arising due to use of energyware also emissions of methane and other volatile organic compounds from the drilling holes are included. Crude oil emanating in drilling test is burnt, emissions are included. Offshore exploration leads to emissions of drilling chemicals and drilling sludge to the sea, though a lot of it is cleaned on the platform before it is emitted. Other emissions to the sea are heavy metals from the drilled sea bed, oil and intraformation water. Some of the drilling chemicals and sludge is brought to the shore as waste. Waste of onshore activities are of the same kind. It is put in landfills, land-farming or casted (emissions from these processes are included). Extraction Average on- and offshore extraction has been inventoried regarding construction and demolition of platforms, towers, pipelines etc., use of energyware, materials (steel and concrete) and land/sea bed. Cleaning of crude oil from water and gas is included as well as flaring of gas, leaks, blow-outs and low pressure venting (emissions of mercury and radioactive radon are accounted for since these elements are found in the gas). Different methods of energyware demanding pumping processes are needed when the pressure in the oil source is too low to allow oil from emanating by itself. Water can be pumped into the oil source or gas recovered from the oil source can be compressed and led back into the oil source, there are also several other methods to enhance the oil gain in the extraction process (all these processes are included). Production chemicals, for ex. anticorrosives, and drilling chemicals as well as emissions of those chemicals are included. Onshore, 90% of the intraformation water is assumed to be pumped into hollows deep in the ground the rest is led into a fresh water recipient. Offshore 100% of the intraformation water is emitted to the sea. Shipping of supplies is included. Production waste consist of scale i.e. mineral deposits in equipment and pipelines. Scale is low level radioactive. Dismantling process of oil platforms is not included and the whole platform including drillhole mantelings and pipelines is assumed to be deposited, i.e. no recycling. Long-distance transports The average transport situation has been scanned. Transports with pipeline (on- and offshore), tanker, train, barge and lorry have been taken into account. Construction, demolition and maintenance of infrastructure (vehicles, pipelines, ships) has been included as well as energyware consumption (extraction included), emissions and waste. Electricity consumption and land use of harbours is included. Losses due to vapourization of oil have been taken into account. Oil emissions due to regularly occurring leaks in pipelines and smaller accidents etc. are included. Refineries The major part of oil products consumed in Europe are refined in Europe. Following processes in refineries have been studied: 1. desalination, 2. distillation, 3. coking (cracking process), 4. visbreaking (lowering of viscosity), 5. hydrotreating (cleaning from e.g. sulphur), 6. catalytic cracking, 7. hydrocracking, 8. catalytic reforming, 9. isomerization, 10. alkylation, 11. steamreforming and 12. steamcracking. Losses due to flaring of refinery gas is included. Following are the products of the studied refineries: refinery gas, propane and butane, petrol (leaded and unleaded) and naphtha, kerosene and diesel, light oil, heavy oil and bitumen. The products interesting for power plants are light and heavy oil, emanating from successive processes 1,2,4,5,6.

	The use of additives in certain oil products have been scanned and included as organic chemicals. Resource consumption, emissions and waste in connection with construction, demolition and use of operation chemicals and catalysts of refineries have mostly been gathered from literature. Operation parameters regularly meassured - water and energyware consumption, emissions of SO2, NOx, HC and oil to water, waste etc. - have been received from European refineries. For other parameters only a few occasional values were available. For refineries in the former Soviet Union only specific data concerning VOC-emissions and use of energyware were available, for the rest European figures have been used. Regional distribution Transport of fuel from refinery to power plant is assumed to be a 100 km train transport. Power plant Only base load plants, > 100 MWe, fired with heavy fuel oil (average lower heating value 40 MJ/kg, density 1 kg/l, sulphur concentration 2,4 % by weight) are inventoried. Only common flue gas cleaning equipment have been regarded, de-NOx equipment (SCR and primary measures), sulphur cleaning equipment (REA) and particle filters (textile). Data concerning operation emissions of SO2, NOx and particles have been received from statistics of the different UCPTE* countries but for other parameters mostly default values from literature have been used. Chemical use for cooling water treatment and emissions to water are included (general data for all kinds of thermal power plants). Operation data from German power plants has been used regarding wastes. Net efficiency of power plants has been calculated on basis of country specific information and the UCPTE* average came to be 38%. Construction and demolition data has been determined based on data for a stone coal power plant and specific data for oil-fuelled power plants. Following assumptions have been made for the construction phase: base load plant, net efficiency 38%, lifetime 30 years, operation time 5700 h/year. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries

Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH. Vattenfall's criterion in selecting and aggregating ETH's LCI-results for electricity generation in the UCPTE region has been to make the figures usable as general electricity LCI data in EPDs according to Miljöstyrningsrådets guidelines. Especially parameters (emissions) which have established impact indices - accepted by the EPD system - for one or several environmental impact categories, have been picked out and aggregated as far possible. But also metal and energyware resources have been included, as well as waste, in spite of all waste handling processes related to this dataset being included with respect to use of resources and emissions. The latter is an adaption to other LCI data for electricity generation where waste amounts are reported (since those flows have not been followed to the grave). Since ETH claimes that most of the figures regarding metal emissions have an undefined amount of datagaps all metal emissions are aggregated except for a few which are specified separatly since they are reported for most processes in the lifecycle. Metals are reported as elements although they often are part of compounds. Measuring methods often just give the amounts of the different elements found. All hydrocarbons to water are aggregated to one parameter as well as halogenated organics, since no indices exist (that are accepted by the EPD system so far) for characterisation of the individual substances.
Time Boundary	The figures describe the average operation of studied plants in 1994. But for the flue gas cleaning plant data from 1994/95 have been used. Most of the data used to describe exploration and extraction of oil is younger than 1985. Figures concerning other fuel extraction and processing represent an average of the early nineties. Descriptions and figures of different technical processes come from literature, contractors, public and private institutions and describe the situation of the late eighties. Electricity used during the lifecycle has been assumed to be a mix based on the average generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years).

	All processes, also those conducted in the past, have been assumed to use average technology of the early nineties. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Pipelines 30 years Tanker 24 years Barge 30 years Power plant 30 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	The world has been devided into 7 supply regions for oil: The Middle East, Latin America (including Mexico), North and Central Africa, Europe, former Soviet Union and North America. The European harbours have been grouped into two regions: North Sea Region and the Mediterranean Region. Crude oil from the Middle East, discharged in the Mediterranean harbours, is assumed to pass through the Suez Channel while Middle East oil, discharged in the North Sea Region is supposed to pass Cape Hope. Refinery locations have been devided into three categories: Switzerland, Western Europe and former Soviet Union. Refineries in North America and Africa are assumed to keep the same standard as refineries in Europe. Two refineries in western Europe have been inventoried and one refinery on the border between Poland and German has been studied, the latter based on literature information. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH's LCA for coal power. The ETH study comprises figures concerning use of land, usable content in water storages and amount of turbine water which have not been reported here. The two latter have been excluded due to lack of corresponding data in comparable studies. Use of land has been excluded here because of ETH's advanced approach. Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the indutrial revolution I Modified human impact larger than other species', low degree of culivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of intererst. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is diffrent from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH specifies about 160 radioactive isotopes emitted to air and water. Radioactive emissions reported here are picked out in accordance with SETAC working group report on data

	quality and data availability (to be published in 2001). Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	Allocations have been made with respect to lower heating value or weight. Allocation of flaring and blow-out losses as well as other losses was done with respect to the lower heating value of the two commercialized products: crude oil and natural gas. Other environmental impact in the exploration and extraction phase were allocated to crude oil since only a small part of the natural gas extracted together with crude oil is commercialized. In the refinery, allocation was done in accordance with weight of the oil products in the different subprocesses. The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average electricity generation with oil (larger plants) in the UCTPE countries.
Method	The data has been adapted from the Ökoinventare von Energiesystemen, ETH Zürich 1996 and is an aggregation of the LCI results for the module ''Electricity oil thermal UCPTE'' (Strom oelthermisch, UCPTE).
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters are relatively good. All values are reported with 3 figures. The data are however seldom that accurate. The extraction of oil, including transport are responsible for a large share of the NOx-emissions. The combustion (after flue gas cleaning) contributes to the largest emissions of SO2 and CO2. The combustion also gives the largest NOx-emissions.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Bauxite	10.7			kg	Ground	
	Input	Natural resource	Chromium in ore	0.921			kg	Ground	
	Input	Natural resource	Copper in ore	4.18			kg	Ground	
Notes: From drillhole	Input	Natural resource	Crude oil	73100			kg	Ground	
Notes: Before processing	Input	Natural resource	Hard coal	1490			kg	Ground	
	Input	Natural resource	Iron in ore	527			kg	Ground	
	Input	Natural resource	Lead in ore	0.232			kg	Ground	
Notes: Before extraction	Input	Natural resource	Lignite	1230			kg	Ground	
	Input	Natural resource	Limestone	431			kg	Ground	
	Input	Natural resource	Manganese in ore	0.267			kg	Ground	
Notes: Summation of ''Erdoelgas'' (40,9 MJ/Nm3), ''Grubengas'' (35,9 MJ/kg) and ''Rohgas'' (35 MJ/Nm3). Expressed as Natural gas with lower heating value (35 MJ/Nm3). The heating values are	Input	Natural resource	Natural gas	6058			Nm3	Ground	

acquired from table III 8.1 in the methodology chapter in the Ökoinventare von Energiesystemen, ETH, Zürich 1996									
	Input	Natural resource	Nickel in ore	0.575			kg	Ground	
	Input	Natural resource	Palladium in ore	1.01E-05			kg	Ground	
	Input	Natural resource	Platinum in ore	1.14E-05			kg	Ground	
	Input	Natural resource	Rhodium in ore	1.07E-05			kg	Ground	
	Input	Natural resource	Rock salt	66.3			kg	Ground	
	Input	Natural resource	Uranium in ore	0.0839			kg	Ground	
	Input	Natural resource	Water	1.93E+07			kg	Ground	
	Input	Natural resource	Wood	28.6			kg	Ground	
	Input	Natural resource	Zinc in ore	0.0268			kg	Ground	
Notes: Summation of Ag, Sn, Rh, Mo, Co.	Input	Refined resource	Metals	3.58E-01			kg	Technosphere	
	Output	Emission	1,2-Dichloroethane	1.20E-04			kg	Air	
	Output	Emission	Ag-110m	0.237			kBq	Water	
	Output	Emission	Ag-110m	3.47E-05			kBq	Air	
	Output	Emission	Am-241	0.0851			kBq	Water	
	Output	Emission	Am-241	6.46E-04			kBq	Air	
Notes: BOD5	Output	Emission	BOD	3.62E-01			kg	Water	
	Output	Emission	C-14	4.31			kBq	Water	
	Output	Emission	C-14	52			kBq	Air	
	Output	Emission	C-60	1.47E-03			kBq	Air	
	Output	Emission	Cd	1.58E-02			kg	Air	
	Output	Emission	Cd	4.64E-03			kg	Water	
	Output	Emission	Cd	7.26E-05			kg	Ground	
	Output	Emission	CFC-11	2.66E-05			kg	Air	
	Output	Emission	CFC-114	7.02E-04			kg	Air	
	Output	Emission	CFC-12	5.72E-06			kg	Air	
	Output	Emission	CFC-13	3.59E-06			kg	Air	
	Output	Emission	Cm alpha	0.113			kBq	Water	
	Output	Emission	Cm alpha	1.03E-03			kBq	Air	
	Output	Emission	Cm-244	3.09E-08			kBq	Air	
Notes: CN- is Cyanide ion	Output	Emission	CN-	1.58E-04			kg	Air	
	Output	Emission	CN-	1.72E-02			kg	Water	
	Output	Emission	CO	75.15			kg	Air	
	Output	Emission	CO2	229380			kg	Air	
	Output	Emission	Co-58	0.371			kBq	Water	
	Output	Emission	Co-58	9.85E-04			kBq	Air	
	Output	Emission	Co-60	18.886			kBq	Water	
	Output	Emission	COD	6.14			kg	Water	
	Output	Emission	Cr	2.10E-02			kg	Ground	
	Output	Emission	Cr	4.59E-02			kg	Air	
	Output	Emission	Cr	5.78E-02			kg	Water	
	Output	Emission	Cs-134	2.45E-02			kBq	Air	
	Output	Emission	Cs-134	4.3591			kBq	Water	
	Output	Emission	Cs-137	0.0474			kBq	Air	
	Output	Emission	Cs-137	40.111			kBq	Water	
	Output	Emission	Dichloromethane	2.66E-04			kg	Air	
Notes: 2,3,7,8-Tetrachlorodibenzo-p-Dioxin-equivalents	Output	Emission	Dioxin (TCDD)	1880			ng	Air	
	Output	Emission	Dissolved solids	0.9985			kg	Water	
	Output	Emission	H-1301	2.83E-02			kg	Air	
	Output	Emission	H2S	0.03115			kg	Air	
	Output	Emission	H-3	1.28E+05			kBq	Water	
	Output	Emission	H-3	536			kBq	Air	

Notes: Summation of AOX, 1,1,1-trichloroethane, chlorobenzene, dichloromonofluoromethane, ethylene dichloride, hexachlororethane, metylenchloride, tetrachloroethylene, trichloroethylene, trichloromethane.	Output	Emission	Halogenated organics	4.29E-02			kg	Water	
Notes: Summation of Cl-, F- and I-.	Output	Emission	Halogenids	2.01E+03			kg	Water	
Notes: Summation of I and Br.	Output	Emission	Halogens	7.10E-03			kg	Air	
	Output	Emission	HCFC-21	1.24E-03			kg	Air	
	Output	Emission	HCFC-22	6.31E-06			kg	Air	
	Output	Emission	HCl	2.9199			kg	Air	
Notes: No available index. Same index as NMVOC.	Output	Emission	Hexachlorobenzene	4.89E-09			kg	Air	
	Output	Emission	Hexafluoroethane	1.17E-04			kg	Air	
	Output	Emission	HF	0.31658			kg	Air	
	Output	Emission	HFC-134a	9.93E-17			kg	Air	
	Output	Emission	Hg	1.01E-03			kg	Air	
	Output	Emission	Hg	1.37E-05			kg	Ground	
	Output	Emission	Hg	8.62E-05			kg	Water	
Notes: Summation of acenaphtene, acenaphtylene, alkane, alkene, aromats, benzene, butyl benzyl phtalat, bibutyl p-phtalat, dimethyl p-phtalat, ethylbenzen, volatile hydrocarbons, formaldehyd, glutaraldehyd, hydrocarbons, MTBE (Metyl Tertiary Butyl Eter), phenol, styrol, toluol, triethylenglycol, xylol.	Output	Emission	Hydrocarbons	5.81E+00			kg	Water	
	Output	Emission	I-129	0.185			kBq	Air	
	Output	Emission	I-129	12.3			kBq	Water	
	Output	Emission	I-131	0.00818			kBq	Water	
	Output	Emission	I-131	0.0206			kBq	Air	
	Output	Emission	I-133	0.00198			kBq	Water	
	Output	Emission	I-133	0.0115			kBq	Air	
	Output	Emission	K-40	0.0998			kBq	Air	
	Output	Emission	K-40	1.67			kBq	Water	
	Output	Emission	Kr-85	3.18E+06			kBq	Air	
Notes: Summation of the ions of following metals: Ag, Al, Ar, Ba, Be, Cs, Ca, Fe, K, Co, Mg, Mn, Mo, Na, Ni, Ru, Sb, Se, Sn, Sr, Ti, W.	Output	Emission	Metal ions	1.41E+03			kg	Water	
Notes: Summation of Al, As, Ca, Co, Cu, Fe, Mn, Ni, Sn.	Output	Emission	Metals	2.96E+01			kg	Ground	
Notes: Summation of Al, As, Ba, Be, Ca, Co, Cu, Fe, K, La, Mg, Mn, Mo, Ni, Pt, Sb, Sc, Se, Sn, Sr, Th, Ti, Tl, U, Zr.	Output	Emission	Metals	4.16E+00			kg	Air	
	Output	Emission	Methane	307.021			kg	Air	
	Output	Emission	Mn-54	2.8873			kBq	Water	
	Output	Emission	Mn-54	3.52E-05			kBq	Air	
	Output	Emission	N	3.87E-03			kg	Ground	
	Output	Emission	N total	7.423			kg	Water	
	Output	Emission	N2O	5.5335			kg	Air	
	Output	Emission	NH3	0.22435			kg	Air	
Notes: Summation of acetaldehyd, acetylene, aceton, acrolein, aldehyd, alkane, alkene, aromats, benzaldehyd, benzene, butan, buten, acetic acid, etan, etanol, etene, ethylbenzene, ethylenoxide (C2H4O), formaldehyd, heptan, hexan, metanol, MTBE (Metyl Tertiary Butyl Eter), NMVOC, pentane, phenol, propan, propen, propion aldehyd, propionic acid, styrol, toluol, xylol.	Output	Emission	NMVOC	5.88E+02			kg	Air	
	Output	Emission	NO2-	3.54E-03			kg	Water	

	Output	Emission	NO3-	2.677			kg	Water	
Notes: as NO2	Output	Emission	NOx	504.6			kg	Air	
	Output	Emission	Np-237	0.00543			kBq	Water	
	Output	Emission	Oil	3.16E+00			kg	Ground	
	Output	Emission	Oil	6.98E+01			kg	Water	
	Output	Emission	P	0.215			kg	Ground	
	Output	Emission	P total	3.22E-03			kg	Air	
	Output	Emission	PAH	4.76E-02			kg	Water	
Notes: Same index as NMVOC.	Output	Emission	PAH	5.34E-03			kg	Air	
	Output	Emission	Particles	96.87			kg	Air	
	Output	Emission	Pb	1.36E-01			kg	Air	
	Output	Emission	Pb	2.27E-03			kg	Ground	
	Output	Emission	Pb	2.80E-02			kg	Water	
	Output	Emission	Pb-210	0.579			kBq	Air	
	Output	Emission	Pb-210	1.33			kBq	Water	
Notes: C6HCl5, no available index. Same index as NMVOC.	Output	Emission	Pentachlorobenzene	1.31E-08			kg	Air	
Notes: C6HCl5O, no available index. Same index as NMVOC.	Output	Emission	Pentachlorophenol	2.11E-09			kg	Air	
	Output	Emission	Po-210	0.869			kBq	Air	
	Output	Emission	Po-210	1.33			kBq	Water	
	Output	Emission	PO43-	1.93E-01			kg	Water	
	Output	Emission	Pu alpha	0.00205			kBq	Air	
	Output	Emission	Pu alpha	0.338			kBq	Water	
	Output	Emission	Pu-238	7.69E-08			kBq	Air	
	Output	Emission	Ra-226	0.7345			kBq	Air	
	Output	Emission	Ra-226	1936			kBq	Water	
Notes: Long-term emissions of Rn-222	Output	Emission	Rn-222	4.57E+06			kBq	Air	
	Output	Emission	Rn-222	5.01E+04			kBq	Air	
	Output	Emission	Ru-106	0.205			kBq	Air	
	Output	Emission	Ru-106	20.5			kBq	Water	
	Output	Emission	S	2.52			kg	Ground	
Notes: Includes Tot-S, S-, S in H2S, S in sulphate, S in sulphite	Output	Emission	S total	3.31E+01			kg	Water	
	Output	Emission	Sb-124	0.061			kBq	Water	
	Output	Emission	Sb-124	9.52E-06			kBq	Air	
	Output	Emission	Sb-125	0.00352			kBq	Water	
	Output	Emission	Sb-125	1.22E-06			kBq	Air	
	Output	Emission	SO2	2359.4			kg	Air	
	Output	Emission	Sr-90	0.0338			kBq	Air	
	Output	Emission	Sr-90	4.10E+00			kBq	Water	
	Output	Emission	Suspended solids	196.949			kg	Water	
	Output	Emission	Tc-99	1.44E-06			kBq	Air	
	Output	Emission	Tc-99	2.15			kBq	Water	
	Output	Emission	Tetrachloromethane	7.24E-05			kg	Air	
	Output	Emission	Tetrafluoromethane	0.00105			kg	Air	
	Output	Emission	Th-230	0.228			kBq	Air	
	Output	Emission	Th-230	59.4			kBq	Water	
	Output	Emission	Th-232	0.0263			kBq	Air	
	Output	Emission	Th-232	0.311			kBq	Water	
Notes: Summation of dissolved organic carbon, fat acids as C, volatile organic compounds as C, TOC.	Output	Emission	Total organic carbon	7.13E+01			kg	Water	
	Output	Emission	Tributyl tin	3.20E-03			kg	Water	
	Output	Emission	Trichloromethane	3.18E-06			kg	Air	
	Output	Emission	U-234	0.246			kBq	Air	
	Output	Emission	U-234	0.508			kBq	Water	
	Output	Emission	U-235	0.0119			kBq	Air	
	Output	Emission	U-235	0.757			kBq	Water	
	Output	Emission	U-238	0.3175			kBq	Air	
	Output	Emission	U-238	1.82			kBq	Water	
	Output	Emission	V	1.57E-02			kg	Water	
	Output	Emission	V	4.03E+00			kg	Air	
	Output	Emission	Vinyl chloride	1.96E-05			kg	Air	
	Output	Emission	Xe-133	2280			kBq	Air	

	Output	Emission	Zn	1.14E-01			kg	Air	
	Output	Emission	Zn	1.25E-01			kg	Water	
	Output	Emission	Zn	6.80E-02			kg	Ground	
	Output	Product	Electricity	1			TJ	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) and processing of hazardous waste is included.	Output	Residue	Hazardous waste	6.62E+01			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Highly radioactive waste	1.44E-05			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, no emissions from landfill assumed. Inert waste deposit is waste at landfill that are inert.	Output	Residue	Inert waste deposit	1.00E+03			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Low radioactive waste	1.47E-02			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Medium and low radioactive waste	1.76E-04			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from landfill. Reactive waste deposit is waste at landfill that is still reactive.	Output	Residue	Reactive waste deposit	1.00E+03			kg	Technosphere	
Notes: Internal flow! Infrastructure of spreading vehicles and emissions are included. Land farming is a treatment of organic sludge, the sludge is spread on a piece of land and left to degrade. Sometimes plants are grown on the land, but those plants are destroyed.	Output	Residue	Waste in land farming	4.43E+02			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from incineration plant.	Output	Residue	Waste to incineration	4.64E+00			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www.energieforschung.ch. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their lifecycles. The results can be used in lifecycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans. Vattenfalls purpose - as a commissioner of putting ETH:s data into Spine format with metadata - is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines. Data is supposed to be used together with IEA statistics about electricity generation mixes in the OECD countries/regions.
Detailed Purpose	ETH:s aim was to describe the average situation in UCPTE concerning electricity generation with oil. With the help of assumptions and simplifications following phases of the life cycle are described: exploration (on- and offshore) extraction (on- and offshore), long-distance transports, refinery, distribution and power plant.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .

Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Data reported here is supposed to be representative for oil electricity generation in the UCPTE countries in 1994. This set of data is aggregated and documented in accordance with the Swedish EPD-guidelines to be used in combination with IEA statistics concerning electricity generation mixes in OECD countries and regions together with other datasets - based on the ETH study - describing other power generation systems. The EPD-adapted power generation systems in Spine format are named as follows: Fuel gas electricity energy system, EPD-version Biofuel electricity energy system, EPD-version Hydro electricity energy system, EPD-version Lignite electricity energy system, EPD-version Nuclear electricity energy system, EPD-version Stone coal electricity energy system, EPD-version Wind electricity energy system, EPD-version IEA statistics for generation mixes 1998 exist in Spine format for the following 30 countries/regions: OECD total OECD North America OECD Pacific OECD Europe European Union Australia Austria Belgium Canada Czech Rpublic Denmark Finland France Germany Greece Hungary Iceland Ireland Italy Japan Korea Luxembourg Mexico Netherlands New Zealand Norway Poland Portugal Spain Sweden Switzerland Turkey United Kingdom United States
About Data	Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided). Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of ETH:s data and metadata has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of aggregation of figures and of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. The technical committee of the Swedish Environmental Management Council - approval of method and aggregation of parameters Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger

	Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut -- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 6 June 2001: <<< Changes made by Ann-Christin Pålsson, CPM based on discussions with Caroline Setterwall, Vattenfall AB. Comments: The following changes has been made in the nomenclature for in- and outflows: Mangane in ore -> changed to: Manganese in ore CH4 -> changed to: Methane (to be in accordance with the nomenclature specified in CPM report 2000:2) CN -> changed to: CN- Stone coal -> changed to: Hard coal (to be in accordance with the nomenclature specified in CPM report 2000:2) Other metals -> changed to: Metals Explanations of nomenclature (inserted in Notes for the specific flows): - CN- is Cyanide ion - Reactive waste deposit is waste at landfill that is still reactive. - Inert waste deposit is waste at landfill that are inert. Additional clarifications: - Note that the flows of waste in the table of in- and outflows are internal flows, i.e. they do NOT cross the system boundaries. All waste handling processes is included in the study with respect to use of resources and emissions. - Radioactive waste is accounted for in cubic metres. The product specific requirements for electricity and district heating generation (PSR 1998:1) in the Swedish EPD system states that waste shall be accounted for in gram. However, no conversion factors were given in the study. There are also no general conversion factors that are commonly used.

SPINE LCI dataset: Oil electricity energy system, ETH - full version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Oil electricity energy system, ETH - full version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures come from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996. Brief description The phases inventoried in ETH's life cycle stydy of electricity generation with oil are: exploration, extraction (onshore and offshore), transports, refinery, regional distribution and power plant operation. The average situation in the UCPTE* region in 1994 concerning the

origin of the oil, transports of different kinds (Swiss conditions), refinery processes, distribution, power plant operation etc. is described.

All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle.

Detailed description

Exploration
Drilling activities during exploration of crude oil (onshore and offshore) have been inventoried regarding use of energyware, drilling chemicals, water, steel and concrete (coating of drilling holes) and use of land/sea bed (not included in the figures, see other boundaries). Besides emissions arising due to use of energyware also emissions of methane and other volatile organic compounds from the drilling holes are included. Crude oil emanating in drilling test is burnt, emissions are included.
Offshore exploration leads to emissions of drilling chemicals and drilling sludge to the sea, though a lot of it is cleaned on the platform before it is emitted. Other emissions to the sea are heavy metals from the drilled sea bed, oil and intraformation water. Some of the drilling chemicals and sludge is brought to the shore as waste.
Waste of onshore activities are of the same kind. It is put in landfills, land-farming or casted (emissions from these processes are included).

Extraction
Average on- and offshore extraction has been inventoried regarding construction and demolition of platforms, towers, pipelines etc., use of energyware, materials (steel and concrete) and land/sea bed.
Cleaning of crude oil from water and gas is included as well as flaring of gas, leaks, blow-outs and low pressure venting (emissions of mercury and radioactive radon are accounted for since these elements are found in the gas).
Different methods of energyware demanding pumping processes are needed when the pressure in the oil source is too low to allow oil from emanating by itself. Water can be pumped into the oil source or gas recovered from the oil source can be compressed and led back into the oil source, there are also several other methods to enhance the oil gain in the extraction process (all these processes are included).
Production chemicals, for ex. anticorrosives, and drilling chemicals as well as emissions of those chemicals are included.
Onshore, 90% of the intraformation water is assumed to be pumped into hollows deep in the ground the rest is led into a fresh water recipient. Offshore 100% of the intraformation water is emitted to the sea.
Shipping of supplies is included.
Production waste consist of scale i.e. mineral deposits in equipment and pipelines. Scale is low level radioactive.
Dismantling process of oil platforms is not included and the whole platform including drillhole mantelings and pipelines is assumed to be deposited, i.e. no recycling.

Long-distance transports
The average transport situation has been scanned. Transports with pipeline (on- and offshore), tanker, train, barge and lorry have been taken into account. Construction, demolition and maintenance of infrastructure (vehicles, pipelines, ships) has been included as well as energyware consumption (extraction included), emissions and waste. Electricity consumption and land use of harbours is included.
Losses due to vapourization of oil have been taken into account. Oil emissions due to regularly occurring leaks in pipelines and smaller accidents etc. are included.

Refineries
The major part of oil products consumed in Europe are refined in Europe.
Following processes in refineries have been studied: 1. desalination, 2. distillation, 3. coking (cracking process), 4. visbreaking (lowering of viscosity), 5. hydrotreating (cleaning from e.g. sulphur), 6. catalytic cracking, 7. hydrocracking, 8. catalytic reforming, 9. isomerization, 10. alkylation, 11. steamreforming and 12. steamcracking. Losses due to flaring of refinery gas is included.
Following are the products of the studied refineries: refinery gas, propane and butane, petrol (leaded and unleaded) and naphtha, kerosene and diesel, light oil, heavy oil and bitumen. The products interesting for power plants are light and heavy oil, emanating from successive processes 1,2,4,5,6.
The use of additives in certain oil products have been scanned and included as organic chemicals.
Resource consumption, emissions and waste in connection with construction, demolition and use of operation chemicals and catalysts of refineries have mostly been gathered from literature. Operation parameters regularly meassured - water and energyware consumption, emissions of SO_2, NO_x, HC and oil to water, waste etc. - have been received from European refineries. For other parameters only a few occasional values were available. For refineries in the former Soviet Union only specific data concerning VOC-emissions and use of energyware were available, for the rest European figures have been used.

Regional distribution
Transport of fuel from refinery to power plant is assumed to be a 100 km train transport.

Power plant
Only base load plants, > 100 MWe, fired with heavy fuel oil (average lower heating value 40 MJ/kg, density 1 kg/l, sulphur concentration 2,4 % by weight) are inventoried. Only common flue gas cleaning equipment have been regarded, de-NO_x equipment (SCR and primary measures), sulphur cleaning equipment (REA) and particle filters (textile).
Data concerning operation emissions of SO_2, NO_x and particles have been received from

	statistics of the different UCPTE* countries but for other parameters mostly default values from literature have been used. Chemical use for cooling water treatment and emissions to water are included (general data for all kinds of thermal power plants). Operation data from German power plants has been used regarding wastes. Net efficiency of power plants has been calculated on basis of country specific information and the UCPTE* average came to be 38%. Construction and demolition data has been determined based on data for a stone coal power plant and specific data for oil-fuelled power plants. Following assumptions have been made for the construction phase: base load plant, net efficiency 38%, lifetime 30 years, operation time 5700 h/year. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries

Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the industrial revolution I Modified human impact larger than other species', low degree of cultivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of interest. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is different from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH.
Time Boundary	The figures describe the average operation of studied plants in 1994. But for the flue gas cleaning plant data from 1994/95 have been used. Most of the data used to describe exploration and extraction of oil is younger than 1985. Figures concerning other fuel extraction and processing represent an average of the early nineties. Descriptions and figures of different technical processes come from literature, contractors, public and private institutions and describe the situation of the late eighties. Electricity used during the lifecycle has been assumed to be a mix based on the average generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years). All processes, also those conducted in the past, have been assumed to use average technology of the early nineties. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Pipelines 30 years Tanker 24 years Barge 30 years Power plant 30 years * Union pour la coordination de la production et du transport de l'életricité, following

	countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	The world has been devided into 7 supply regions for oil: The Middle East, Latin America (including Mexico), North and Central Africa, Europe, former Soviet Union and North America. The European harbours have been grouped into two regions: North Sea Region and the Mediterranean Region. Crude oil from the Middle East, discharged in the Mediterranean harbours, is assumed to pass through the Suez Channel while Middle East oil, discharged in the North Sea Region is supposed to pass Cape Hope. Refinery locations have been devided into three categories: Switzerland, Western Europe and former Soviet Union. Refineries in North America and Africa are assumed to keep the same standard as refineries in Europe. Two refineries in western Europe have been inventoried and one refinery on the border between Poland and German has been studied, the latter based on literature information. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH's LCA for coal power. Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	Allocations have been made with respect to lower heating value or weight. Allocation of flaring and blow-out losses as well as other losses was done with respect to the lower heating value of the two commercialized products: crude oil and natural gas. Other environmental impact in the exploration and extraction phase were allocated to crude oil since only a small part of the natural gas extracted together with crude oil is commercialized. In the refinery, allocation was done in accordance with weight of the oil products in the different subprocesses. The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average electricity generation with oil (larger plants) in the UCTPE countries.
Method	The figures have been copied from the module ''Electricity oil thermal UCPTE'' (Strom oelthermisch, UCPTE) in the Ökoinventare von Energiesystemen, ETH Zürich 1996.
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	Multiple flows are reported for several emissions to air. This is because that in the original study emissions to air have been reported in three categories, indicated by one of the letters below following the substance name. - m = mobile (emissions from vehicles) - p = process (process specific emissions as for instance methane emissions during coal mining) -

	s = stationary (emissions from stationary combustion plants) This categorisation has however not been documented in this specification in the SPINE format.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Area II-III	389			m2a	Ground	
	Input	Natural resource	Area III-IV	111			m2a	Ground	
	Input	Natural resource	Area II-IV	139			m2a	Ground	
	Input	Natural resource	Area IV-IV	1.41			m2a	Ground	
	Input	Natural resource	Area, sea bed II-III	5090			m2a	Ground	
	Input	Natural resource	Area, sea bed II-IV	525			m2a	Ground	
	Input	Natural resource	Barite	320			kg	Ground	
	Input	Natural resource	Bauxite	10.7			kg	Ground	
	Input	Natural resource	Bentonite	27.1			kg	Ground	
	Input	Natural resource	Chromium in ore	0.921			kg	Ground	
	Input	Natural resource	Clay	72.7			kg	Ground	
	Input	Natural resource	Copper in ore	4.18			kg	Ground	
	Input	Natural resource	Crude oil	73.1			tonne	Ground	
	Input	Natural resource	Gravel	1120			kg	Ground	
	Input	Natural resource	Hydro energy	0.00555			TJ	Water	
	Input	Natural resource	Iron in ore	527			kg	Ground	
	Input	Natural resource	Lead in ore	0.232			kg	Ground	
	Input	Natural resource	Lignite	1230			kg	Ground	
	Input	Natural resource	Limestone	431			kg	Ground	
	Input	Natural resource	Manganese in ore	0.267			kg	Ground	
	Input	Natural resource	Mine gas (methane)	10.9			kg	Ground	
	Input	Natural resource	Natural gas	204			Nm3	Ground	
	Input	Natural resource	Natural gas	5000			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.575			kg	Ground	
	Input	Natural resource	Palladium in ore	0.0000101			kg	Ground	
	Input	Natural resource	Platinum in ore	0.0000114			kg	Ground	
	Input	Natural resource	Rhodium in ore	0.0000107			kg	Ground	
	Input	Natural resource	Rock salt	66.3			kg	Ground	
	Input	Natural resource	Sand	123			kg	Ground	
	Input	Natural resource	Stone coal	1490			kg	Ground	
	Input	Natural resource	Turbine water amount	29200			m3	Water	
	Input	Natural resource	Uranium in ore	0.0839			kg	Ground	
	Input	Natural resource	Water	19300000			kg	Ground	
	Input	Natural resource	Wood	0.0286			tonne	Ground	

	Input	Natural resource	Working amount in water storages	121			m3a	Water	
	Input	Natural resource	Zinc in ore	0.0268			kg	Ground	
	Input	Refined resource	Cobalt	0.00000383			kg	Technosphere	
	Input	Refined resource	Molybdenum	0.00000885			kg	Technosphere	
	Input	Refined resource	Rhenium	0.0000108			kg	Technosphere	
	Input	Refined resource	Silver	0.23			kg	Technosphere	
	Input	Refined resource	Tin	0.128			kg	Technosphere	
	Output	Emission	1,1,1-Trichloroethane	0.000000193			kg	Fresh water	
	Output	Emission	1,2-Dichloroethane	0.0000618			kg	Fresh water	
	Output	Emission	1,2-Dichloroethane	0.00012			kg	Air	
	Output	Emission	Acenaphthylene	0.000395			kg	Fresh water	
	Output	Emission	Acetaldehyde	0.648			kg	Air	
	Output	Emission	Acetic acid	2.6			kg	Air	
	Output	Emission	Acetone	0.648			kg	Air	
	Output	Emission	Acetylene	0.000375			kg	Air	
	Output	Emission	Acids	0.002			kg	Fresh water	
	Output	Emission	Acroleine	0.00000152			kg	Air	
	Output	Emission	Ag	0.000278			kg	Fresh water	
	Output	Emission	Ag	0.00195			kg	Sea water	
	Output	Emission	Ag-110m	0.0000347			kBq	Air	
	Output	Emission	Ag-110m	0.237			kBq	Fresh water	
	Output	Emission	Al	0.00335			kg	Air	
	Output	Emission	Al	0.00405			kg	Air	
	Output	Emission	Al	0.00546			kg	Sea water	
	Output	Emission	Al	0.0638			kg	Air	
	Output	Emission	Al	2.65			kg	Fresh water	
	Output	Emission	Al	4.2			kg	Ground	
	Output	Emission	Aldehydes	0.000067			kg	Air	
	Output	Emission	Alkanes	0.0527			kg	Fresh water	
	Output	Emission	Alkanes	0.423			kg	Sea water	
	Output	Emission	Alkanes	1.42			kg	Air	
	Output	Emission	Alkanes	2.6			kg	Air	
	Output	Emission	Alkenes	0.000147			kg	Air	
	Output	Emission	Alkenes	0.00486			kg	Fresh water	
	Output	Emission	Alkenes	0.0391			kg	Sea water	
	Output	Emission	Alkenes	0.135			kg	Air	
	Output	Emission	Alpha radiator	0.0000281			kBq	Fresh water	
	Output	Emission	Am-241	0.000646			kBq	Air	
	Output	Emission	Am-241	0.0851			kBq	Sea water	
	Output	Emission	AOX	0.00494			kg	Sea water	
	Output	Emission	AOX	0.00859			kg	Fresh water	
	Output	Emission	Ar-41	75.4			kBq	Air	
	Output	Emission	Aromates	0.0000147			kg	Air	
	Output	Emission	Aromates	0.261			kg	Air	
	Output	Emission	Aromatics	0.212			kg	Fresh water	
	Output	Emission	Aromatics	1.98			kg	Sea water	
	Output	Emission	As	0.000111			kg	Air	
	Output	Emission	As	0.000405			kg	Air	
	Output	Emission	As	0.00109			kg	Sea water	
	Output	Emission	As	0.00168			kg	Ground	
	Output	Emission	As	0.00715			kg	Fresh water	
	Output	Emission	As	0.0259			kg	Air	
	Output	Emission	B	0.0000085			kg	Air	
	Output	Emission	B	0.0438			kg	Sea water	
	Output	Emission	B	0.0473			kg	Air	
	Output	Emission	B	0.0903			kg	Fresh water	
	Output	Emission	Ba	0.0000312			kg	Air	
	Output	Emission	Ba	0.00103			kg	Air	
	Output	Emission	Ba	1.31			kg	Fresh water	
	Output	Emission	Ba	8.15			kg	Sea water	

	Output	Emission	Ba-140	0.000136			kBq	Air	
	Output	Emission	Ba-140	0.000432			kBq	Fresh water	
	Output	Emission	Barite	63.4			kg	Sea water	
	Output	Emission	Be	0.000000376			kg	Air	
	Output	Emission	Be	0.00000295			kg	Fresh water	
	Output	Emission	Be	0.0000112			kg	Air	
	Output	Emission	Benzaldehyde	0.000000795			kg	Air	
	Output	Emission	Benzene	0.00046			kg	Air	
	Output	Emission	Benzene	0.053			kg	Fresh water	
	Output	Emission	Benzene	0.134			kg	Air	
	Output	Emission	Benzene	0.424			kg	Sea water	
	Output	Emission	Benzene	0.563			kg	Air	
	Output	Emission	Benzo(a)pyrene	0.000000376			kg	Air	
	Output	Emission	Benzo(a)pyrene	0.0000951			kg	Air	
	Output	Emission	BOD	0.0583			kg	Sea water	
	Output	Emission	BOD	0.304			kg	Fresh water	
	Output	Emission	Br	0.0000118			kg	Air	
	Output	Emission	Br	0.00488			kg	Air	
	Output	Emission	Butane	0.00754			kg	Air	
	Output	Emission	Butane	5.54			kg	Air	
	Output	Emission	Butene	0.135			kg	Air	
	Output	Emission	C	13			kg	Ground	
	Output	Emission	C-14	4.31			kBq	Sea water	
	Output	Emission	C-14	52			kBq	Air	
	Output	Emission	Ca	0.00347			kg	Air	
	Output	Emission	Ca	0.0198			kg	Air	
	Output	Emission	Ca	0.25			kg	Air	
	Output	Emission	Ca	105			kg	Sea water	
	Output	Emission	Ca	16.8			kg	Ground	
	Output	Emission	Ca	45.3			kg	Fresh water	
	Output	Emission	Cd	0.00000209			kg	Air	
	Output	Emission	Cd	0.0000726			kg	Ground	
	Output	Emission	Cd	0.00021			kg	Air	
	Output	Emission	Cd	0.00207			kg	Sea water	
	Output	Emission	Cd	0.00257			kg	Fresh water	
	Output	Emission	Cd	0.0156			kg	Air	
	Output	Emission	Cd-109	0.0000025			kBq	Fresh water	
	Output	Emission	Ce-141	0.00000322			kBq	Air	
	Output	Emission	Ce-141	0.0000646			kBq	Fresh water	
	Output	Emission	Ce-144	0.0000184			kBq	Fresh water	
	Output	Emission	Ce-144	0.00687			kBq	Air	
	Output	Emission	Ce-144	1.95			kBq	Sea water	
	Output	Emission	CFC-11	0.0000266			kg	Air	
	Output	Emission	CFC-114	0.000702			kg	Air	
	Output	Emission	CFC-12	0.00000572			kg	Air	
	Output	Emission	CFC-13	0.00000359			kg	Air	
	Output	Emission	CH4	0.221			kg	Air	
	Output	Emission	CH4	16.8			kg	Air	
	Output	Emission	CH4	290			kg	Air	
	Output	Emission	Chlorinated solvents	0.0000581			kg	Fresh water	
	Output	Emission	Chlorobenzenes	9.21E-10			kg	Fresh water	
	Output	Emission	Cl-	1670			kg	Sea water	
	Output	Emission	Cl-	340			kg	Fresh water	
	Output	Emission	ClO-	0.877			kg	Fresh water	
	Output	Emission	ClO-	0.976			kg	Sea water	
	Output	Emission	Cm alpha	0.00103			kBq	Air	
	Output	Emission	Cm alpha	0.113			kBq	Sea water	
	Output	Emission	Cm-242	3.41E-09			kBq	Air	
	Output	Emission	Cm-244	3.09E-08			kBq	Air	
	Output	Emission	CN	0.000158			kg	Air	
	Output	Emission	CN	4.83E-12			kg	Air	
	Output	Emission	CN-	0.00546			kg	Sea water	
	Output	Emission	CN-	0.0117			kg	Fresh water	
	Output	Emission	Co	0.0000494			kg	Air	
	Output	Emission	Co	0.0000998			kg	Ground	

	Output	Emission	Co	0.000249			kg	Air	
	Output	Emission	Co	0.00479			kg	Fresh water	
	Output	Emission	Co	0.132			kg	Air	
	Output	Emission	CO	2.11			kg	Air	
	Output	Emission	CO	6.14			kg	Air	
	Output	Emission	CO	66.9			kg	Air	
	Output	Emission	CO2	2000			kg	Air	
	Output	Emission	CO2	219000			kg	Air	
	Output	Emission	CO2	8380			kg	Air	
	Output	Emission	Co-57	0.000443			kBq	Fresh water	
	Output	Emission	Co-57	5.95E-08			kBq	Air	
	Output	Emission	Co-58	0.000985			kBq	Air	
	Output	Emission	Co-58	0.371			kBq	Fresh water	
	Output	Emission	Co-60	0.00147			kBq	Air	
	Output	Emission	Co-60	0.386			kBq	Fresh water	
	Output	Emission	Co-60	18.5			kBq	Sea water	
	Output	Emission	COD	1.15			kg	Sea water	
	Output	Emission	COD	4.99			kg	Fresh water	
	Output	Emission	Cr	0.000197			kg	Air	
	Output	Emission	Cr	0.000581			kg	Air	
	Output	Emission	Cr	0.021			kg	Ground	
	Output	Emission	Cr	0.0451			kg	Air	
	Output	Emission	Cr(VI)	0.00000331			kg	Fresh water	
	Output	Emission	Cr3+	0.0272			kg	Sea water	
	Output	Emission	Cr3+	0.0306			kg	Fresh water	
	Output	Emission	Cr-51	0.000122			kBq	Air	
	Output	Emission	Cr-51	0.0095			kBq	Fresh water	
	Output	Emission	Cs	0.000405			kg	Fresh water	
	Output	Emission	Cs	0.00326			kg	Sea water	
	Output	Emission	Cs-134	0.0245			kBq	Air	
	Output	Emission	Cs-134	0.0491			kBq	Fresh water	
	Output	Emission	Cs-134	4.31			kBq	Sea water	
	Output	Emission	Cs-136	0.00000232			kBq	Fresh water	
	Output	Emission	Cs-137	0.0474			kBq	Air	
	Output	Emission	Cs-137	0.111			kBq	Fresh water	
	Output	Emission	Cs-137	40			kBq	Sea water	
	Output	Emission	Cu	0.000444			kg	Air	
	Output	Emission	Cu	0.000499			kg	Ground	
	Output	Emission	Cu	0.00435			kg	Sea water	
	Output	Emission	Cu	0.00979			kg	Air	
	Output	Emission	Cu	0.0167			kg	Fresh water	
	Output	Emission	Cu	0.179			kg	Air	
	Output	Emission	Di-(2-ethylhexyl) phthalate	6.93E-09			kg	Fresh water	
	Output	Emission	Dibutyl p-phthalate	0.00000004			kg	Fresh water	
	Output	Emission	Dichloromethane	0.000266			kg	Air	
	Output	Emission	Dichloromethane	0.0292			kg	Fresh water	
	Output	Emission	Different beta	0.0000044			kBq	Air	
	Output	Emission	Dimethyl p-phthalate	0.000000252			kg	Fresh water	
	Output	Emission	Dioxin (TCDD)	1880			ng	Air	
	Output	Emission	Dissolved organic carbon	0.000649			kg	Sea water	
	Output	Emission	Dissolved organic carbon	0.00236			kg	Fresh water	
	Output	Emission	Dissolved solids	0.0825			kg	Sea water	
	Output	Emission	Dissolved solids	0.916			kg	Fresh water	
	Output	Emission	Ethane	0.00377			kg	Air	
	Output	Emission	Ethane	1.38			kg	Air	
	Output	Emission	Ethanol	0.0000173			kg	Air	
	Output	Emission	Ethanol	1.3			kg	Air	
	Output	Emission	Ethene	0.0081			kg	Air	
	Output	Emission	Ethene	0.363			kg	Air	
	Output	Emission	Ethylbenzene	0.00526			kg	Air	
	Output	Emission	Ethylbenzene	0.00976			kg	Fresh water	
	Output	Emission	Ethylbenzene	0.0782			kg	Sea water	
	Output	Emission	Ethylbenzene	0.132			kg	Air	
	Output	Emission	F-	0.0326			kg	Sea water	
	Output	Emission	F-	0.465			kg	Fresh water	

	Output	Emission	Fe	0.00752			kg	Air	
	Output	Emission	Fe	0.0323			kg	Air	
	Output	Emission	Fe	0.38			kg	Sea water	
	Output	Emission	Fe	0.428			kg	Air	
	Output	Emission	Fe	3.89			kg	Fresh water	
	Output	Emission	Fe	8.4			kg	Ground	
	Output	Emission	Fe-59	0.00000135			kBq	Air	
	Output	Emission	Fe-59	0.00000765			kBq	Fresh water	
	Output	Emission	Fission and rad. prod.	0.255			kBq	Fresh water	
	Output	Emission	Formaldehyde	0.00000321			kg	Fresh water	
	Output	Emission	Formaldehyde	0.0000494			kg	Air	
	Output	Emission	Formaldehyde	1.95			kg	Air	
	Output	Emission	Glutaraldehyde	0.00782			kg	Sea water	
	Output	Emission	H-1301	0.0283			kg	Air	
	Output	Emission	H2S	0.000703			kg	Fresh water	
	Output	Emission	H2S	0.00305			kg	Air	
	Output	Emission	H2S	0.0281			kg	Air	
	Output	Emission	H-3	123000			kBq	Sea water	
	Output	Emission	H-3	4530			kBq	Fresh water	
	Output	Emission	H-3	536			kBq	Air	
	Output	Emission	HCFC-21	0.00124			kg	Air	
	Output	Emission	HCFC-22	0.00000631			kg	Air	
	Output	Emission	HCl	0.0299			kg	Air	
	Output	Emission	HCl	2.89			kg	Air	
	Output	Emission	He	0.657			kg	Air	
	Output	Emission	He	4.38			kg	Air	
	Output	Emission	Heat	0.000263			TJ	Ground	
	Output	Emission	Heat	0.00459			TJ	Air	
	Output	Emission	Heat	0.0288			TJ	Air	
	Output	Emission	Heat	0.319			TJ	Sea water	
	Output	Emission	Heat	0.34			TJ	Fresh water	
	Output	Emission	Heat	1.65			TJ	Air	
	Output	Emission	Heptane	1.32			kg	Air	
	Output	Emission	Hexachlorobenzene	4.89E-09			kg	Air	
	Output	Emission	Hexachloroethane	1.37E-09			kg	Fresh water	
	Output	Emission	Hexafluoroethane	0.000117			kg	Air	
	Output	Emission	Hexane	2.76			kg	Air	
	Output	Emission	HF	0.00558			kg	Air	
	Output	Emission	HF	0.311			kg	Air	
	Output	Emission	HFC-134a	9.93E-17			kg	Air	
	Output	Emission	Hg	0.0000111			kg	Sea water	
	Output	Emission	Hg	0.0000116			kg	Air	
	Output	Emission	Hg	0.0000137			kg	Ground	
	Output	Emission	Hg	0.0000751			kg	Fresh water	
	Output	Emission	Hg	0.0000788			kg	Air	
	Output	Emission	Hg	0.000923			kg	Air	
	Output	Emission	HOCl	0.877			kg	Fresh water	
	Output	Emission	HOCl	0.976			kg	Sea water	
	Output	Emission	Hydrocarbons	0.00106			kg	Fresh water	
	Output	Emission	I	0.0000088			kg	Air	
	Output	Emission	I	0.0022			kg	Air	
	Output	Emission	I	0.0405			kg	Fresh water	
	Output	Emission	I	0.326			kg	Sea water	
	Output	Emission	I-129	0.185			kBq	Air	
	Output	Emission	I-129	12.3			kBq	Sea water	
	Output	Emission	I-131	0.00818			kBq	Fresh water	
	Output	Emission	I-131	0.0206			kBq	Air	
	Output	Emission	I-133	0.00198			kBq	Fresh water	
	Output	Emission	I-133	0.0115			kBq	Air	
	Output	Emission	I-135	0.0172			kBq	Air	
	Output	Emission	K	0.00825			kg	Air	
	Output	Emission	K	0.0905			kg	Air	
	Output	Emission	K	14.2			kg	Sea water	
	Output	Emission	K	4.73			kg	Fresh water	
	Output	Emission	K-40	0.0998			kBq	Air	

	Output	Emission	K-40	1.67			kBq	Fresh water	
	Output	Emission	Kr-85	3180000			kBq	Air	
	Output	Emission	Kr-85m	3.79			kBq	Air	
	Output	Emission	Kr-87	1.69			kBq	Air	
	Output	Emission	Kr-88	150			kBq	Air	
	Output	Emission	Kr-89	1.19			kBq	Air	
	Output	Emission	La	0.00000156			kg	Air	
	Output	Emission	La	0.0000297			kg	Air	
	Output	Emission	La-140	0.0000858			kBq	Air	
	Output	Emission	La-140	0.0000895			kBq	Fresh water	
	Output	Emission	Methanol	1.3			kg	Air	
	Output	Emission	Methyl Tertiary Butyl Ether	0.0000012			kg	Sea water	
	Output	Emission	Methyl Tertiary Butyl Ether	0.00000208			kg	Fresh water	
	Output	Emission	Methyl Tertiary Butyl Ether	0.0000401			kg	Air	
	Output	Emission	Mg	0.00234			kg	Air	
	Output	Emission	Mg	0.0227			kg	Air	
	Output	Emission	Mg	2.18			kg	Sea water	
	Output	Emission	Mg	6.2			kg	Fresh water	
	Output	Emission	Mn	0.0243			kg	Air	
	Output	Emission	Mn	0.0405			kg	Air	
	Output	Emission	Mn	0.117			kg	Fresh water	
	Output	Emission	Mn	0.152			kg	Sea water	
	Output	Emission	Mn	0.168			kg	Ground	
	Output	Emission	Mn-54	0.0000352			kBq	Air	
	Output	Emission	Mn-54	0.0173			kBq	Fresh water	
	Output	Emission	Mn-54	2.87			kBq	Sea water	
	Output	Emission	Mo	0.000000463			kg	Air	
	Output	Emission	Mo	0.000324			kg	Air	
	Output	Emission	Mo	0.00109			kg	Sea water	
	Output	Emission	Mo	0.00988			kg	Fresh water	
	Output	Emission	Mo	0.0299			kg	Air	
	Output	Emission	Mo-99	0.0000302			kBq	Fresh water	
	Output	Emission	N	0.00387			kg	Ground	
	Output	Emission	N total	1.46			kg	Sea water	
	Output	Emission	N total	2.54			kg	Fresh water	
	Output	Emission	N2	0.058			kg	Air	
	Output	Emission	N2O	0.0205			kg	Air	
	Output	Emission	N2O	0.143			kg	Air	
	Output	Emission	N2O	5.37			kg	Air	
	Output	Emission	Na	0.000156			kg	Air	
	Output	Emission	Na	0.0203			kg	Air	
	Output	Emission	Na	1.62			kg	Air	
	Output	Emission	Na	1010			kg	Sea water	
	Output	Emission	Na	188			kg	Fresh water	
	Output	Emission	Na-24	0.0133			kBq	Fresh water	
	Output	Emission	Nb-95	0.00000623			kBq	Air	
	Output	Emission	Nb-95	0.000245			kBq	Fresh water	
	Output	Emission	NH3	0.00135			kg	Air	
	Output	Emission	NH3	0.223			kg	Air	
	Output	Emission	NH4+ as N	1.09			kg	Sea water	
	Output	Emission	NH4+ as N	1.94			kg	Fresh water	
	Output	Emission	Ni	0.000749			kg	Ground	
	Output	Emission	Ni	0.00345			kg	Air	
	Output	Emission	Ni	0.00761			kg	Sea water	
	Output	Emission	Ni	0.0156			kg	Fresh water	
	Output	Emission	Ni	0.0197			kg	Air	
	Output	Emission	Ni	1.09			kg	Air	
	Output	Emission	NMVOC	0.576			kg	Air	
	Output	Emission	NMVOC	5.04			kg	Air	
	Output	Emission	NMVOC	543			kg	Air	
	Output	Emission	NO2-	0.000264			kg	Fresh water	
	Output	Emission	NO2-	0.00328			kg	Sea water	
	Output	Emission	NO3-	0.897			kg	Sea water	
	Output	Emission	NO3-	1.78			kg	Fresh water	
	Output	Emission	Noble gases (radioactive)	4.57			kBq	Air	

	Output	Emission	NOx	14.3			kg	Air	
	Output	Emission	NOx	2.33			kg	Air	
	Output	Emission	NOx	488			kg	Air	
	Output	Emission	Np-237	0.00543			kBq	Sea water	
	Output	Emission	Np-237	3.38E-08			kBq	Air	
	Output	Emission	Nuclide mix	0.000184			kBq	Fresh water	
	Output	Emission	Oil	0.000447			kg	Ground	
	Output	Emission	Oil	0.477			kg	Fresh water	
	Output	Emission	Oil	66.2			kg	Sea water	
	Output	Emission	Organic N	0.143			kg	Sea water	
	Output	Emission	Organic N	0.25			kg	Fresh water	
	Output	Emission	P	0.0000264			kg	Air	
	Output	Emission	P	0.000884			kg	Air	
	Output	Emission	P	0.00231			kg	Air	
	Output	Emission	P	0.215			kg	Ground	
	Output	Emission	P	3.16			kg	Ground	
	Output	Emission	Pa-234m	0.0205			kBq	Air	
	Output	Emission	Pa-234m	0.38			kBq	Fresh water	
	Output	Emission	PAH	0.00000393			kg	Air	
	Output	Emission	PAH	0.00524			kg	Air	
	Output	Emission	PAH	0.00533			kg	Fresh water	
	Output	Emission	PAH	0.0423			kg	Sea water	
	Output	Emission	Particles	1.42			kg	Air	
	Output	Emission	Particles	7.05			kg	Air	
	Output	Emission	Particles	88.4			kg	Air	
	Output	Emission	Pb	0.00109			kg	Sea water	
	Output	Emission	Pb	0.00152			kg	Air	
	Output	Emission	Pb	0.00176			kg	Air	
	Output	Emission	Pb	0.00227			kg	Ground	
	Output	Emission	Pb	0.0269			kg	Fresh water	
	Output	Emission	Pb	0.133			kg	Air	
	Output	Emission	Pb-210	0.228			kBq	Air	
	Output	Emission	Pb-210	0.351			kBq	Air	
	Output	Emission	Pb-210	1.33			kBq	Fresh water	
	Output	Emission	Pentachlorobenzene	1.31E-08			kg	Air	
	Output	Emission	Pentachlorophenol	2.11E-09			kg	Air	
	Output	Emission	Pentane	0.0138			kg	Air	
	Output	Emission	Pentane	6.97			kg	Air	
	Output	Emission	Phenol	0.00015			kg	Air	
	Output	Emission	Phenol	0.109			kg	Fresh water	
	Output	Emission	Phenol	0.388			kg	Sea water	
	Output	Emission	Phosphoric compound	0.00178			kg	Fresh water	
	Output	Emission	Pm-147	0.0174			kBq	Air	
	Output	Emission	Po-210	0.228			kBq	Air	
	Output	Emission	Po-210	0.641			kBq	Air	
	Output	Emission	Po-210	1.33			kBq	Fresh water	
	Output	Emission	PO43-	0.0109			kg	Sea water	
	Output	Emission	PO43-	0.182			kg	Fresh water	
	Output	Emission	Propane	0.135			kg	Air	
	Output	Emission	Propane	5.48			kg	Air	
	Output	Emission	Propene	0.001			kg	Air	
	Output	Emission	Propene	0.264			kg	Air	
	Output	Emission	Propionic acid	0.000129			kg	Air	
	Output	Emission	Propionic aldehyde	0.000000795			kg	Air	
	Output	Emission	Pt	0.00000232			kg	Air	
	Output	Emission	Pu alpha	0.00205			kBq	Air	
	Output	Emission	Pu alpha	0.338			kBq	Sea water	
	Output	Emission	Pu-238	7.69E-08			kBq	Air	
	Output	Emission	Pu-241 beta	0.0564			kBq	Air	
	Output	Emission	Pu-241 beta	8.41			kBq	Sea water	
	Output	Emission	Ra-224	163			kBq	Sea water	
	Output	Emission	Ra-224	20.2			kBq	Fresh water	
	Output	Emission	Ra-226	0.0905			kBq	Air	
	Output	Emission	Ra-226	0.644			kBq	Air	
	Output	Emission	Ra-226	1610			kBq	Fresh water	

	Output	Emission	Ra-226	326			kBq	Sea water	
	Output	Emission	Ra-228	0.049			kBq	Air	
	Output	Emission	Ra-228	326			kBq	Sea water	
	Output	Emission	Ra-228	40.5			kBq	Fresh water	
	Output	Emission	Rb	0.00405			kg	Fresh water	
	Output	Emission	Rb	0.0326			kg	Sea water	
	Output	Emission	Rn-220	4.55			kBq	Air	
	Output	Emission	Rn-222	447			kBq	Air	
	Output	Emission	Rn-222	49700			kBq	Air	
	Output	Emission	Rn-222 (long term)	4570000			kBq	Air	
	Output	Emission	Ru-103	0.000000352			kBq	Air	
	Output	Emission	Ru-103	0.000145			kBq	Fresh water	
	Output	Emission	Ru-106	0.205			kBq	Air	
	Output	Emission	Ru-106	20.5			kBq	Sea water	
	Output	Emission	S	2.52			kg	Ground	
	Output	Emission	S2-	0.0437			kg	Sea water	
	Output	Emission	S2-	0.076			kg	Fresh water	
	Output	Emission	Salt	4.44			kg	Fresh water	
	Output	Emission	Sb	0.00000017			kg	Air	
	Output	Emission	Sb	0.0000596			kg	Air	
	Output	Emission	Sb	0.000122			kg	Fresh water	
	Output	Emission	Sb-122	0.000432			kBq	Fresh water	
	Output	Emission	Sb-124	0.00000952			kBq	Air	
	Output	Emission	Sb-124	0.061			kBq	Fresh water	
	Output	Emission	Sb-125	0.00000122			kBq	Air	
	Output	Emission	Sb-125	0.00352			kBq	Fresh water	
	Output	Emission	Sc	0.000000614			kg	Air	
	Output	Emission	Sc	0.00000991			kg	Air	
	Output	Emission	Se	0.000116			kg	Air	
	Output	Emission	Se	0.00109			kg	Sea water	
	Output	Emission	Se	0.00146			kg	Air	
	Output	Emission	Se	0.0141			kg	Fresh water	
	Output	Emission	Se	0.0204			kg	Air	
	Output	Emission	Si	0.00347			kg	Air	
	Output	Emission	Si	0.00387			kg	Air	
	Output	Emission	Si	0.0326			kg	Fresh water	
	Output	Emission	Si	0.23			kg	Air	
	Output	Emission	Sn	0.000000312			kg	Air	
	Output	Emission	Sn	0.0000219			kg	Air	
	Output	Emission	Sn	0.0000854			kg	Fresh water	
	Output	Emission	SO2	2280			kg	Air	
	Output	Emission	SO2	37.1			kg	Air	
	Output	Emission	SO2	42.3			kg	Air	
	Output	Emission	SO32-	0.00423			kg	Fresh water	
	Output	Emission	SO42-	20			kg	Sea water	
	Output	Emission	SO42-	79.8			kg	Fresh water	
	Output	Emission	Sr	0.0000312			kg	Air	
	Output	Emission	Sr	0.00104			kg	Air	
	Output	Emission	Sr	19.6			kg	Sea water	
	Output	Emission	Sr	2.6			kg	Fresh water	
	Output	Emission	Sr-89	0.0000616			kBq	Air	
	Output	Emission	Sr-89	0.000977			kBq	Fresh water	
	Output	Emission	Sr-90	0.00036			kBq	Fresh water	
	Output	Emission	Sr-90	0.0338			kBq	Air	
	Output	Emission	Sr-90	4.1			kBq	Sea water	
	Output	Emission	Suspended solids	0.949			kg	Fresh water	
	Output	Emission	Suspended solids	196			kg	Sea water	
	Output	Emission	Tc-99	0.00000144			kBq	Air	
	Output	Emission	Tc-99	2.15			kBq	Sea water	
	Output	Emission	Tc-99m	0.000204			kBq	Fresh water	
	Output	Emission	Te-123	0.0000182			kBq	Fresh water	
	Output	Emission	Te-123m	0.000155			kBq	Air	
	Output	Emission	Te-132	0.00000747			kBq	Fresh water	
	Output	Emission	Tetrachloroethene	0.000000163			kg	Fresh water	
	Output	Emission	Tetrachloromethane	0.000000249			kg	Fresh water	

	Output	Emission	Tetrachloromethane	0.0000724			kg	Air	
	Output	Emission	Tetrafluoromethane	0.00105			kg	Air	
	Output	Emission	Th	0.000000614			kg	Air	
	Output	Emission	Th	0.0000191			kg	Air	
	Output	Emission	Th-228	0.0415			kBq	Air	
	Output	Emission	Th-228	651			kBq	Sea water	
	Output	Emission	Th-228	81			kBq	Fresh water	
	Output	Emission	Th-230	0.228			kBq	Air	
	Output	Emission	Th-230	59.4			kBq	Fresh water	
	Output	Emission	Th-232	0.0263			kBq	Air	
	Output	Emission	Th-232	0.311			kBq	Fresh water	
	Output	Emission	Th-234	0.0205			kBq	Air	
	Output	Emission	Th-234	0.383			kBq	Fresh water	
	Output	Emission	Ti	0.0000944			kg	Air	
	Output	Emission	Ti	0.00286			kg	Air	
	Output	Emission	Ti	0.144			kg	Fresh water	
	Output	Emission	Tl	0.000000156			kg	Air	
	Output	Emission	Tl	0.00000736			kg	Air	
	Output	Emission	Toluene	0.00481			kg	Air	
	Output	Emission	Toluene	0.044			kg	Fresh water	
	Output	Emission	Toluene	0.352			kg	Sea water	
	Output	Emission	Toluene	0.809			kg	Air	
	Output	Emission	Total organic carbon	1.98			kg	Fresh water	
	Output	Emission	Total organic carbon	16.6			kg	Sea water	
	Output	Emission	Total organic carbon	21.6			kg	Sea water	
	Output	Emission	Total organic carbon	29.8			kg	Fresh water	
	Output	Emission	Tributyltin	0.0032			kg	Sea water	
	Output	Emission	Trichloroethene	0.0000103			kg	Fresh water	
	Output	Emission	Trichloromethane	0.00000318			kg	Air	
	Output	Emission	Trichloromethane	0.0000378			kg	Fresh water	
	Output	Emission	Triethylene glycol	0.000649			kg	Sea water	
	Output	Emission	Triethylene glycol	0.00236			kg	Fresh water	
	Output	Emission	U	0.000000312			kg	Air	
	Output	Emission	U	0.0000215			kg	Air	
	Output	Emission	U alpha	0.0707			kBq	Sea water	
	Output	Emission	U alpha	0.735			kBq	Air	
	Output	Emission	U alpha	24.8			kBq	Fresh water	
	Output	Emission	U-234	0.246			kBq	Air	
	Output	Emission	U-234	0.508			kBq	Fresh water	
	Output	Emission	U-235	0.0119			kBq	Air	
	Output	Emission	U-235	0.757			kBq	Fresh water	
	Output	Emission	U-238	0.0755			kBq	Air	
	Output	Emission	U-238	0.242			kBq	Air	
	Output	Emission	U-238	1.82			kBq	Fresh water	
	Output	Emission	V	0.0000701			kg	Air	
	Output	Emission	V	0.00109			kg	Sea water	
	Output	Emission	V	0.0146			kg	Fresh water	
	Output	Emission	V	0.0515			kg	Air	
	Output	Emission	V	3.98			kg	Air	
	Output	Emission	W	0.0000764			kg	Fresh water	
	Output	Emission	Vinyl chloride	0.0000196			kg	Air	
	Output	Emission	Vinyl chloride	4.63E-08			kg	Fresh water	
	Output	Emission	VOC	0.142			kg	Fresh water	
	Output	Emission	VOC	1.14			kg	Sea water	
	Output	Emission	Xe-121m	7.8			kBq	Air	
	Output	Emission	Xe-133	2280			kBq	Air	
	Output	Emission	Xe-133m	1.15			kBq	Air	
	Output	Emission	Xe-135	390			kBq	Air	
	Output	Emission	Xe-135m	38.8			kBq	Air	
	Output	Emission	Xe-137	0.96			kBq	Air	
	Output	Emission	Xe-138	10.5			kBq	Air	
	Output	Emission	Xylene	0.0383			kg	Fresh water	
	Output	Emission	Xylene	0.306			kg	Sea water	
	Output	Emission	Xylol	0.0224			kg	Air	
	Output	Emission	Xylol	0.534			kg	Air	

	Output	Emission	Y-90	0.0000499			kBq	Fresh water	
	Output	Emission	Zn	0.00576			kg	Air	
	Output	Emission	Zn	0.01			kg	Air	
	Output	Emission	Zn	0.0109			kg	Sea water	
	Output	Emission	Zn	0.068			kg	Ground	
	Output	Emission	Zn	0.0978			kg	Air	
	Output	Emission	Zn	0.114			kg	Fresh water	
	Output	Emission	Zn-65	0.000151			kBq	Air	
	Output	Emission	Zn-65	0.0281			kBq	Fresh water	
	Output	Emission	Zr	0.00000755			kg	Air	
	Output	Emission	Zr-95	0.00000225			kBq	Air	
	Output	Emission	Zr-95	0.0000596			kBq	Fresh water	
	Output	Emission	Zr-95	0.174			kBq	Sea water	
	Output	Product	Electricity	1			TJ	Technosphere	
	Output	Residue	Hazardous waste	66.2			kg	Technosphere	
	Output	Residue	Highly radioactive waste	0.0147			kg	Technosphere	
	Output	Residue	Inert waste deposit	1000			kg	Technosphere	
	Output	Residue	Low radioactive waste	0.0000144			kg	Technosphere	
	Output	Residue	Medium and low radioactive waste	0.000176			kg	Technosphere	
	Output	Residue	Reactive waste deposit	24.9			kg	Technosphere	
	Output	Residue	Waste deposit	976			kg	Technosphere	
	Output	Residue	Waste in land farming	443			kg	Technosphere	
	Output	Residue	Waste to incineration	4.64			kg	Technosphere	

About Inventory	
Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www.energieforschung.ch. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their lifecycles. The results can be used in lifecycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans.
Detailed Purpose	ETH:s aim was to describe the average situation in UCPTE concerning electricity generation with oil. With the help of assumptions and simplifications following phases of the life cycle are described: exploration (on- and offshore) extraction (on- and offshore), long-distance transports, refinery, distribution and power plant.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Data reported here is supposed to be representative for oil electricity generation in the UCPTE countries in 1994.
About Data	Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided). Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of metadata describing the ETH study has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data

	documentation requirements. Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut

SPINE LCI dataset: Oil filter combustion

Administrative	
Finished	Y
Date Completed	2002-12-12
Copyright	
Availability	Public

Technical System	
Name	Oil filter combustion
Functional Unit	0.706 kg of filter
Functional Unit Explanation	The oil filter HC 8904 FKP 16Z weighs 0.706 kg.
Process Type	Gate to grave
Site	Kumla
Sector	
Owner	Kumla
Technical system description	This activity describes oil filter combustion. The oil filters are used to clean circulating oil in a lubricant system. After use, the filters are disposed and burned as waste. Energy is co-produced and total combustion is assumed.

System Boundaries	
Nature Boundary	The filters come from the technospere. The combustion gives emissions to air.
Time Boundary	Data is collected autumn 2002. No changes are planned for the nearest future.
Geographical Boundary	The combustion is performed in Kumla, Sweden.
Other Boundaries	No transports are included.
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	2002-11-29 - 2002-12-31
Data Type	Derived, mixed
Represents	N/A

Method	Personal communication with Mike Day, Pall Corporation and Annika Lorin at SAKAB.
Literature Reference	N/A
Notes	none

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refine resource	Filter Pall HC 8904 FKP 16Z	0.706			kg	Technosphere	Sweden
	Output	Co-product	Recovered energy	11.296			MJ	Technosphere	Sweden
	Output	Emission	CO2	1.26			kg	Air	Sweden
	Output	Emission	NO2	0.094			kg	Air	Sweden

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002 -------------- Data documented by Sandra Häggström, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-03-21.
Intended User	Product developer at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The purpose for our study is to compare a coated roller bearing to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll and is lubricated with a circulating oil system in both cases. The circulating oil is cleaned using filters from Pall, also in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	The data is applicable for coreless oil filters.
About Data	The data is collected by personal communication with Annika Lorin at SAKAB and Mike Day, Pall Corporation. Information about molecular formulas are taken from www.polymerprocessing.com.
Notes	

SPINE LCI dataset: Operation of 'Hot Dogs' producing facility. ESA-DBP

Administrative

Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Operation of 'Hot Dogs' producing facility. ESA-DBP
Functional Unit	1 year of operation of the facility
Functional Unit Explanation	All data originate from the mandatory environmental report that Swedish companies present each year, and they are the cumulative numbers for one year for the whole facility. (NB: no information about the annual volume of production)

Process Type	Gate to gate
Site	Unknown
Sector	Food products and beverages
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''In co-operation with Swedish Meats, a production facility in Örebro, Sweden, was studied. The reason for choosing the particular facility was that it mainly produces one product, named 'Hot Dogs'. (...) The main production process consists of eight processes, of which some may be divided into two or more steps: (...) 1. Grinding - Frozen products are thawed before use. The meat ingredients are ground, and an automatic device is used to supervise the fat content. 2. Pre-mixing - the meat mixture is mixed with water, ice, and salt. 3. Ripening in silo - storage of meat mixture, usually for 1-5 days. Six silos, each with a capacity of 12 tonnes. 4. Recipe mixing - mixing of meat mixture with other ingredients, such as potato starch and spices. A highly automated process, where the operator just defines the amounts, after which the mixture is prepared by the machine. 5. Extruding - four extruding machines, which are loaded with cellulose tubes. The sausage batter is extruded through the tubes at high speed, whereupon casing-covered sausages are formed. The cellulose casing is manufactured by Viscofan SA in Pamplona, Spain. Long strings of sausages are then cooked, smoked and cooled down. 6. Peeling of sausage strings - four parallel machines use steam to peel the casing off the sausages. 7. Packaging - six packaging lines with various capacity, each including several steps: positioning, vacuum packaging (big rolls of plastic wrapping are heat-moulded into shape, sausages are inserted, and the packages are sealed), scale/metal detector, (defective products are removed), picker (a fast robot loads the packages into plastic trays), robot loading trays on pallet. 8. Loading area - facility office; stock input to logistics software, and back-reporting of customer orders. This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Pea-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Pea cultivation. ESA-DBP - Production of beef. ESA-DBP - Production of pork. ESA-DBP - Rape seed cultivation. ESA-DBP - Wheat cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean processing. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries

Nature Boundary	The data relate only to the operation of the production facility. It includes energy use, emissions to water, water use, chemical consumption and waste generation.
Time Boundary	The data were acquired from the report for the year 2005.
Geographical Boundary	The facility is located in Örebro, Sweden.
Other Boundaries	The facility produces mainly only 1 product 'Hot Dogs'.
Allocations	The data was given per 1 year.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2005
Data Type	Derived, unspecified
Represents	See 'Function'

Method	Acquired from the environmental report of the company. Emission to water recalculated to kg from reported mg/l in waste water.
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf The particular data come from: Persson, D. (2005) Swedish Meats, Örebro, Sweden. Personal Communication
Notes	none

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Water	1.28E+05			m3	Water	Sweden
	Input	Refined resource	Biogas	2.21E+04			GJ	Technosphere	Sweden
	Input	Refined resource	Chemicals	2.72E+04			tonne	Technosphere	Sweden
	Input	Refined resource	District heating	3.53E+03			GJ	Technosphere	Sweden
	Input	Refined resource	Electricity	1.02E+04			GJ	Technosphere	Sweden
	Input	Refined resource	Oil	3.63E+03			GJ	Technosphere	Sweden
	Output	Emission	BOD	29400			kg	Water	Sweden
	Output	Emission	COD	61900			kg	Water	Sweden
	Output	Emission	Fat	3600			kg	Water	Sweden
	Output	Emission	N	1350			kg	Water	Sweden
	Output	Emission	pH	412			kg	Water	Sweden
	Output	Emission	Phosphorus	386			kg	Water	Sweden
	Output	Residue	Compost	7.42E+01			tonne	Technosphere	Sweden
	Output	Residue	Electronics scrap	1.81E+00			tonne	Technosphere	Sweden
	Output	Residue	Metals	3.39E+00			tonne	Technosphere	Sweden
	Output	Residue	Recycled cardboard	3.19E+01			tonne	Technosphere	Sweden
	Output	Residue	Recycled hard plastics	4.50E-01			tonne	Technosphere	Sweden
	Output	Residue	Recycled paper	3.73E+01			tonne	Technosphere	Sweden
	Output	Residue	Recycled soft plastics	2.40E+00			tonne	Technosphere	Sweden
	Output	Residue	Sludge from water treatment	6.85E+02			m3	Technosphere	Sweden
	Output	Residue	Waste to deposit	4.59E+01			tonne	Technosphere	Sweden
	Output	Residue	Waste to energy production	1.80E+02			tonne	Technosphere	Sweden
	Output	Residue	Waste water	6.44E+04			m3	Technosphere	Sweden
	Output	Residue	Water for cooling	1.56E+04			m3	Water	Sweden
	Output	Residue	Wood	1.00E+00			tonne	Technosphere	Sweden

About Inventory

Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .
Practitioner	Anders Abelmann - Chalmers University of Technology.
Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above

About Data	____ ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment c Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The data for operation 'Hot dogs' producing facility were taken from: Persson, D. (2005) Swedish Meats, Örebro, Sweden. Personal Communication

SPINE LCI dataset: Operation of large scale waste water treatment plant. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation of large scale waste water treatment plant. ESA-DBP
Functional Unit	person·year
Functional Unit Explanation	These flows were normalized to the functional unit which is treatment of the sewage from one person-equivalent during one year. The person-equivalent is a fictitious person who spends all his or her time in Kronan.
Process Type	Gate to grave
Site	Building area 'Kronan', Luleå
Sector	Waste treatment
Owner	Building area 'Kronan', Luleå
Technical system description	The study was performed for the projected housing area Kronan in Luleå, a city in Northern Sweden. The system was designed for the area that accomodates 2700 inhabitants and provides workspace for 1000 people. Excerpt from the report, see 'Publication': In the conventional system, all sewage from the housing area would be pumped to the existing Uddebo Waste Water Treatment Plant (WWTP), which currently serves 72000 person equivalents (pe). The estimated reduction rates of a process including chemical precipitation with ferric chloride and a projected biological treatment step (without nitrification) were 95% for phosphorus and biological oxygen demand (BOD) and 30% for nitrogen. It was estimated that the sludge from the treatment plant would contain 95% of incoming phosphorus and 18% of the incoming nitrogen. The sludge would be stored 6-12 months before being transported by truck to farms on an average distance of 25 km from Luleå and applied as fertilizer. This process is included in the system described in: Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf Other processes in the CPM Database also included in the above publication: Operation of waste water treatment plant with urine and sludge separation . ESA-DBP Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP Operation of small-scale waste water treatment plant. ESA-DBP Operation of liquid composting continuous system. ESA-DBP Operation of liquid composting batch process. ESA-DBP Construction of small-scale waste water treatment plant. ESA-DBP

	Construction of liquid composting continous system. ESA-DBP Construction of liquid composting batch system. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) emissions to air, emissions to water, and waste generation.
Time Boundary	The data were acquired in 1997 as the most up-to-date ones. It is assumed that the results should be valid for at least 10 years.
Geographical Boundary	The study was done for Luleå, Sweden.
Other Boundaries	The LCA base model included the collection, treatment, and transportation of wastewater as well as the production of chemicals and other materials required to operate the system. Excerpt from the report, see 'Publication': ''The heating of water has not been included in the analysis since it has been assumed that there will be no difference between the alternatives in the consumption of hot water. For the sake of making a complete description of the technical systems and an analysis of the environmental impact of these systems, it might have been included. In the analysis only the environmental impacts the households cause via the sanitary systems have been regarded. Other environmental impacts of the households have been regarded as irrelevant in this study. The treatment of storm water has not been included in the study. In both alternatives, storm water will be taken care of separately and, consquently, it will not affect the flows of sewage and urine.''
Allocations	No information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data delivered by local authorities
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Excerpt from the report, see 'Publication': ''Local authorities provided site-specific data, while data on equipment were provided by suppliers or estimated from existing systems. General data taken from the literature were used for nutrient content of sewage, the production of precipitation chemicals, fertilizers production, diesel consumption and emissions in the spreading of manure, and the production of different materials.''

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Resource	*Fe	2.35E+03			g	Technosphere	Sweden
	Input	Resource	*Raw phosphate	3.17E+03			g	Technosphere	Sweden
	Input	Resource	Bauxite	5.10E-03			g	Ground	Sweden
	Input	Resource	Bio fuel	2.02E+03			g	Technosphere	Sweden
	Input	Resource	CO2	1.74E+03			g	Technosphere	Sweden
	Input	Resource	Copper ore	7.90E+01			g	Ground	Sweden
	Input	Resource	Diesel	1.34E+01			kWh	Technosphere	Sweden
	Input	Resource	Gas	-1.29E+00			kWh	Technosphere	Sweden
	Input	Resource	H2SO4	-2.93E+03			g	Technosphere	Sweden
	Input	Resource	Iron ore	2.55E+00			g	Ground	Sweden
	Input	Resource	Land use	3.49E-01			m2	Ground	Sweden
	Input	Resource	Lead ore	9.13E-01			g	Ground	Sweden
	Input	Resource	Limestone	3.90E+03			g	Technosphere	Sweden
	Input	Resource	Na2CO3-	9.48E-01			g	Technosphere	Sweden
	Input	Resource	NaCl	3.57E+03			g	Technosphere	Sweden
	Input	Resource	NaOH	2.02E-01			g	Technosphere	Sweden
	Input	Resource	NH3	6.00E-01			g	Technosphere	Sweden
	Input	Resource	Nitric acid	2.92E-01			g	Technosphere	Sweden
	Input	Resource	Oil	2.51E+01			kWh	Technosphere	Sweden

	Input	Resource	Uranium ore	4.62E+01			g	Technosphere	Sweden
	Input	Resource	Wood	1.78E-01			g	Ground	Sweden
	Output	By-product	Biogas	5.87E+01			kWh	Technosphere	Sweden
	Output	Emission	BOD	8.75E+02			g	Air	Sweden
	Output	Emission	CH4	1.92E-02			g	Air	Sweden
	Output	Emission	Cl2	1.10E-03			g	Air	Sweden
	Output	Emission	CO	1.80E+01			g	Air	Sweden
	Output	Emission	CO2	4.68E+03			g	Air	Sweden
	Output	Emission	COD	8.40E-03			g	Air	Sweden
	Output	Emission	HC	2.85E+00			g	Air	Sweden
	Output	Emission	N2O	-6.98E+00			g	Air	Sweden
	Output	Emission	NH3	2.20E+02			g	Air	Sweden
	Output	Emission	NH4-N	-5.73E+00			g	Air	Sweden
	Output	Emission	NOx	8.14E+01			g	Air	Sweden
	Output	Emission	N-tot	3.40E+03			g	Air	Sweden
	Output	Emission	Oil	-2.90E-03			g	Air	Sweden
	Output	Emission	Particles	4.65E+00			g	Air	Sweden
	Output	Emission	P-tot	3.60E+01			g	Air	Sweden
	Output	Emission	SO2	6.65E+00			g	Air	Sweden
	Output	Emission	VOC	2.30E+00			g	Air	Sweden
	Output	Residue	Ashes	-5.53E-02			g	Technosphere	Sweden
	Output	Residue	Building waste	2.53E+00			g	Technosphere	Sweden
	Output	Residue	Gypsum and heavy metals	-4.73E+03			g	Technosphere	Sweden
	Output	Residue	Hazardous waste	8.67E+00			g	Technosphere	Sweden
	Output	Residue	Highly active rad ac waste	1.69E+00			g	Technosphere	Sweden
	Output	Residue	Low active rad ac waste	1.00E-03			g	Technosphere	Sweden
	Output	Residue	Mineral waste	3.73E+02			g	Technosphere	Sweden
	Output	Residue	Other rest products	3.79E+03			g	Technosphere	Sweden
	Output	Residue	Radioactivity	3.80E+03			kBq	Technosphere	Sweden
	Output	Residue	Waste	2.74E+02			g	Technosphere	Sweden

About Inventory

Publication	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf
Intended User	LCA practitioner, Waste Water Treatment System Specialist
General Purpose	Excerpt from the report, see 'Publication': ''The LCAs were performed on planned wastewater systems in areas within three Swedish minicipalities; Luleå, Västerås and Strömstad. Apart from the case studies a literature study of substitutability of nutrients in sewage compared to artificial fertilizers was performed.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The study has been made in order to find out the environmental consequences of two different sewage treatment alternatives for the projected housing area Kronan in the city of Luleå.(...) The major difference between the alternatives studied is that in one case the urine will be taken care of separately, while in the other the urine will be treated together with the rest of the sewage in a conventional way''
Commissioner	Swedish Environmental Agency - .
Practitioner	Bengtsson, Magnus - TEP, Chalmers University of Technology.
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).

Notes	NB: The results from the project were also used in the following paper: Lundin M., Bengtsson M., Molander S. (2000). Life Cycle Assessment of Wastewater Systems: Influence of System Boundaries and Scale on Calculated Environmental Loads. Technical Environmental Planning, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf

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SPINE LCI dataset: Operation of liquid composting batch process. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation of liquid composting batch process. ESA-DBP
Functional Unit	person·year
Functional Unit Explanation	The functional unit chosen is the treatment of one persons sewage and organic waste during one year. The sewage treatment includes black water and grey water.
Process Type	Gate to grave
Site	WWTP in Horn, Sweden
Sector	Waste treatment
Owner	WWTP in Horn, Sweden
Technical system description	Liquid composting batch process was one of the options considered for a little village Horn in the municipality of Västerås, which is a small, planned village of 200 inhabitants situated in a rural area in central Sweden. The other options were: liquid composting continuous process and conventional waste water treatment plant. The main function of the discussed solution is to treat the toilet and organic kitchen waste. In this solution (excerpt from the report, see 'Publication') ''toilet and kitchen waste is treated batchwise in a liquid composting tank. (...) Grey water (bath, shower and laundry) is treated separately in a sludge separator, filter beds and open ditches. The liquid composted sludge and the filter bed sand are spread on agricultural land. Liquid composting is an aerobic thermophilic digestion where organic material is stabilised in a reactor by adding enough air to induce aerobic degradation which increases the temperature. Ideally, the sludge should contain at least 3% solids and therefore conventional toilets can not be used, since they need too much water. In order to reach the high temperature (60-65 °C) the reactor needs to be well insulated and organic kitchen waste is mixed with the black water to increase the energy content. The mixture has a resident time of 7 days in the reactor. After treatment, the compost sludge is pumped to a storage tank and after a period of 6 months to one year ready to be spread on farmland.'' The raw sludge consists of black water and flush water, kitchen waste and the septage from a septic tank which is a part of the grey water treatment. The batch system consists of a buffer tank and collection tank. The treatment takes place in the storage tank, similar to the collection tank where the sludge is aerated once a year for about one month. ''Considering the operation, the batch process is less electricity consuming. In the compost organic material is converted to CO_2 and nitrogen is released to air as NH_3. To avoid odour and ammonia emissions the air from the reactor needs to be treated before it is released to the atmosphere. This treatment consists of a condensation step where most of the ammonia is condensed and returned to the reactor, followed by a biofilter (peat) where the rest of the ammonia can be either bound to the peat, transformed to nitrogen gas or released unaffected. (...) It is assumed that all nitrogen is captured in the peat and returned to agriculture. Further it is also assumed that small quantities of CH_4 and N_2O which might be produced in the compost are eliminated in a well-functioning biofilter. The peat is changed twice every year and used as fertiliser. In a full-scale system it is likely that some nitrogen will pass the biofilter as N_2 or NH_3, these assumptions are therefore believed to be slightly optimistic.''

	This process is included in the system described in: Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf Other processes in the CPM Database also included in the above publication: Operation of waste water treatment plant with urine and sludge separation . ESA-DBP Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP Operation of small-scale waste water treatment plant. ESA-DBP Operation of liquid composting continuous system. ESA-DBP Operation of large scale waste water treatment plant. ESA-DBP Construction of small-scale waste water treatment plant. ESA-DBP Construction of liquid composting continous system. ESA-DBP Construction of liquid composting batch system. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''The operation of the system concerns first of all the emissions to Lake Freden part of Lake Mälaren. But the operation also has impacts on a larger scale, such as emissions of gaseous pollutants and materials produced in other regions.''
Time Boundary	The data were acquired in 1997 as the most up-to-date ones. Excerpt from the report, see 'Publication': ''The study is made for a wastewater system in a village planned to be built in one or two years. The components of the sanitary system are assumed to have a life time of 15 to 30 years.''
Geographical Boundary	The study was done for the village Horn, Sweden. In the construction analysis it is assumed that most of the equipment is made in Sweden, Norway or Finland.
Other Boundaries	Excerpt from the report, see 'Publication': ''The study includes the handling of wastewater and organic (compostable) kitchen waste, but not other types of waste such as glass, plastics, paper or metals. Furthermore distribution and treatment of drinking water and collection of stormwater are not included in the study. These will be the same for the two alternatives and will not contribute to differences in the comparison. Included in the system are the collection, treatment and transportation of waste and wastewater, and the spreading of nutrients on agricultural land. The production of chemicals and other types of 35 materials needed are included as well as production of electricity and avoided artificial fertiliser. The transportation of the material is not included in the analysis. (...) According to the detailed development plan, 57 houses are to be constructed in the property of Horn in Västerås municipality.''
Allocations	No information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Some of the data delivered by local authorities and some adapted from the other report.
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Production of electricity is not included Local authorities provided site-specific data, while data on equipment were provided by suppliers or estimated from existing systems. General data taken from the literature were used for nutrient content of sewage, the production of precipitation chemicals, fertilizers production, diesel consumption and emissions in the spreading of manure, and the production of different materials.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Diesel	2.51E+01			MJ	Technosphere	Sweden

	Input	Refined resource	Diesel	6.10E-02			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity	9.73E+01			kWh	Technosphere	Sweden
	Input	Resource	Gas	5.60E-03			MJ	Technosphere	Sweden
	Input	Resource	Peat	3.50E-03			m3	Technosphere	Sweden
	Input	Resource	Sand	1.05E+04			m3	Technosphere	Sweden
	Output	By-product	N-tot	4.03E+03			g	Ground	Sweden
	Output	By-product	P-tot	8.30E+02			g	Ground	Sweden
	Output	Emission	BOD	1.02E+03			g	Water	Sweden
	Output	Emission	CH4	1.68E-02			g	Air	Sweden
	Output	Emission	CO	8.45E+00			g	Air	Sweden
	Output	Emission	CO2	1.86E+03			g	Air	Sweden
	Output	Emission	HC	7.40E-01			g	Air	Sweden
	Output	Emission	N2O	7.00E-02			g	Air	Sweden
	Output	Emission	NH3	6.10E+02			g	Air	Sweden
	Output	Emission	NOx	3.01E+01			g	Air	Sweden
	Output	Emission	N-tot	4.50E+01			g	Water	Sweden
	Output	Emission	PAH	4.20E-05			g	Ground	Sweden
	Output	Emission	Particles	8.38E-01			g	Air	Sweden
	Output	Emission	P-tot	2.25E+02			g	Water	Sweden
	Output	Emission	P-tot	5.00E+00			g	Ground	Sweden
	Output	Emission	SO2	7.89E-01			g	Air	Sweden
	Output	Emission	VOC	2.01E+00			g	Air	Sweden

About Inventory

Publication	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf
Intended User	LCA practitioner, Waste Water Treatment System Specialist
General Purpose	Excerpt from the report, see 'Publication': ''The LCAs were performed on planned wastewater systems in areas within three Swedish minicipalities; Luleå, Västerås and Strömstad. Apart from the case studies a literature study of substitutability of nutrients in sewage compared to artificial fertilizers was performed.''
Detailed Purpose	Horn was chosen as an example of small community. Excerpt from the report, see 'Publication': ''This study has been made in order to find out the environmental consequences of two alternatives for the handling of organic waste and sewage for the village of Horn. (...) The question the LCA should answer is: Which technical solution will give the least environmental impact, to treat the toilet and organic kitchen waste by liquid-composting or to treat the wastewater in a small sewage plant and the compostable kitchen waste in a drum compost''
Commissioner	Swedish Environmental Agency - .
Practitioner	Lundin, Margareta - .
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The results from the project were also used in the following paper: Lundin M., Bengtsson M., Molander S. (2000). Life Cycle Assessment of Wastewater Systems: Influence of System Boundaries and Scale on Calculated Environmental Loads. Technical Environmental Planning, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf

SPINE LCI dataset: Operation of liquid composting continuous system. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation of liquid composting continuous system. ESA-DBP
Functional Unit	person·year
Functional Unit Explanation	The functional unit chosen is the treatment of one persons sewage and organic waste during one year. The sewage treatment includes black water and grey water.
Process Type	Gate to grave
Site	WWTP in Horn, Sweden
Sector	Waste treatment
Owner	WWTP in Horn, Sweden
Technical system description	Liquid composting continuous process was one of the options considered for Horn in the municipality of Västerås, which is a small, planned village of 200 inhabitants situated in a rural area in central Sweden. According to the detailed development plan, 57 houses are to be constructed in this area. The other considered options for this area were: liquid composting batch process and conventional waste water treatment plant. The main function of the discussed solution is to treat the toilet and organic kitchen waste. In this solution (excerpt from the report, see 'Publication') ''toilet and kitchen waste is treated continuously in a liquid composting reactor. Grey water (bath, shower and laundry) is treated separately in a sludge separator, filter beds and open ditches. The liquid composted sludge and the filter bed sand are spread on agricultural land. Liquid composting is an aerobic thermophilic digestion where organic material is stabilised in a reactor by adding enough air to induce aerobic degradation which increases the temperature. Ideally, the sludge should contain at least 3% solids and therefore conventional toilets can not be used, since they need too much water. In order to reach the high temperature (60-65 °C) the reactor needs to be well insulated and organic kitchen waste is mixed with the black water to increase the energy content. The mixture has a resident time of 7 days in the reactor. After treatment, the compost sludge is pumped to a storage tank and after a period of 6 months to one year ready to be spread on farmland. (...) The raw sludge consists of black water and flush water, kitchen waste and the septage from a septic tank which is a part of the grey water treatment. Totally 420m3 raw sludge is estimated to be treated yearly. The continuous system consists of a buffer tank and an insulated reactor. An aeration system supplies the reactor with air and mixes the liquid. The electricity demand for aeration and mixing is according to Alfa Laval Agri 30kWh/m3 mixture. The heat from the reactor could be used e.g. for heating the building but is not included in the analysis. In the compost organic material is converted to CO_2 and nitrogen is released to air as NH_3. To avoid odour and ammonia emissions the air from the reactor needs to be treated before it is released to the atmosphere. This treatment consists of a condensation step where most of the ammonia is condensed and returned to the reactor, followed by a biofilter (peat) where the rest of the ammonia can be either bound to the peat, transformed to nitrogen gas or released unaffected. (...) It is assumed that all nitrogen is captured in the peat and returned to agriculture. Further it is also assumed that small quantities of CH_4 and N_2O which might be produced in the compost are eliminated in a well-functioning biofilter. The peat is changed twice every year and used as fertiliser. In a full-scale system it is likely that some nitrogen will pass the biofilter as N_2 or NH_3, these assumptions are therefore believed to be slightly optimistic.'' This process is included in the system described in: Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf Other processes in the CPM Database also included in the above publication: Operation of waste water treatment plant with urine and sludge separation . ESA-DBP

	Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP Operation of small-scale waste water treatment plant. ESA-DBP Operation of liquid composting batch process. ESA-DBP Operation of large scale waste water treatment plant. ESA-DBP Construction of small-scale waste water treatment plant. ESA-DBP Construction of liquid composting continous system. ESA-DBP Construction of liquid composting batch system. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''The operation of the system concerns first of all the emissions to Lake Freden part of Lake Mälaren. But the operation also has impacts on a larger scale, such as emissions of gaseous pollutants and materials produced in other regions.''
Time Boundary	The data were acquired in 1997 as the most up-to-date ones. Excerpt from the report, see 'Publication': ''The study is made for a wastewater system in a village planned to be built in one or two years. The components of the sanitary system are assumed to have a life time of 15 to 30 years.''
Geographical Boundary	The study was done for the village Horn, Sweden. In the construction analysis it is assumed that most of the equipment is made in Sweden, Norway or Finland.
Other Boundaries	Excerpt from the report, see 'Publication': ''The study includes the handling of wastewater and organic (comparable) kitchen waste, but not other types of waste such as glass, plastics, paper or metals. Furthermore distribution and treatment of drinking water and collection of stormwater are not included in the study. These will be the same for the two alternatives and will not contribute to differences in the comparison. Included in the system are the collection, treatment and transportation of waste and wastewater, and the spreading of nutrients on agricultural land. The production of chemicals and other types of 35 materials needed are included (...). The construction does only include the environmental impacts due to the production of the material and not the use, reuse or disposal of the equipment. (...) The transportation of the material is not included in the analysis. (...) According to the detailed development plan, 57 houses are to be constructed in the property of Horn in Västerås municipality.'' Production of electricity is excluded from the study.
Allocations	No information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Local authorities provided site-specific data, while data on equipment were provided by suppliers or estimated from existing systems. General data taken from the literature were used for nutrient content of sewage, the production of precipitation chemicals, fertilizers production, diesel consumption and emissions in the spreading of manure, and the production of different materials.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Diesel	2.51E+01			MJ	Technosphere	Sweden
	Input	Refined resource	Diesel	6.10E-02			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity	1.26E+02			kWh	Technosphere	Sweden
	Input	Resource	Gas	5.60E-03			MJ	Ground	Sweden
	Input	Resource	Peat	3.50E-03			m3	Ground	Sweden
	Input	Resource	Sand	1.05E+04			m3	Ground	Sweden
Notes: Useful flow to agriculture	Output	By-product	N-tot	4.03E+03			g	Ground	Sweden

Notes: Useful flow to agriculture	Output	By-product	P-tot	8.30E+02			g	Ground	Sweden
	Output	Emission	BOD	1.02E+03			g	Water	Sweden
	Output	Emission	CH4	1.68E-02			g	Air	Sweden
	Output	Emission	CO	8.45E+00			g	Air	Sweden
	Output	Emission	CO2	1.86E+03			g	Air	Sweden
	Output	Emission	HC	7.40E-01			g	Air	Sweden
	Output	Emission	N2O	7.00E-02			g	Air	Sweden
	Output	Emission	NH3	6.10E+02			g	Air	Sweden
	Output	Emission	NOx	3.01E+01			g	Air	Sweden
	Output	Emission	N-tot	2.25E+02			g	Water	Sweden
	Output	Emission	PAH	4.20E-05			g	Ground	Sweden
	Output	Emission	Particles	8.38E-01			g	Air	Sweden
	Output	Emission	P-tot	4.50E+01			g	Water	Sweden
	Output	Emission	P-tot	5.00E+00			g	Ground	Sweden
	Output	Emission	SO2	7.89E-01			g	Air	Sweden
	Output	Emission	VOC	2.01E+00			g	Air	Sweden

About Inventory

Publication	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf
Intended User	LCA practitioner, Waste Water Treatment System Specialist
General Purpose	Excerpt from the report, see 'Publication': ''The LCAs were performed on planned wastewater systems in areas within three Swedish minicipalities; Luleå, Västerås and Strömstad. Apart from the case studies a literature study of substitutability of nutrients in sewage compared to artificial fertilizers was performed.''
Detailed Purpose	Horn was chosen as an example of small community. Excerpt from the report, see 'Publication': ''This study has been made in order to find out the environmental consequences of two alternatives for the handling of organic waste and sewage for the village of Horn. (...) The question the LCA should answer is: Which technical solution will give the least environmental impact, to treat the toilet and organic kitchen waste by liquid-composting or to treat the wastewater in a small sewage plant and the compostable kitchen waste in a drum compost''
Commissioner	Swedish Environmental Agency - .
Practitioner	Lundin, Margareta - .
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The results from the project were also used in the following paper: Lundin M., Bengtsson M., Molander S. (2000). Life Cycle Assessment of Wastewater Systems: Influence of System Boundaries and Scale on Calculated Environmental Loads. Technical Environmental Planning, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf

SPINE LCI dataset: Operation of small-scale waste water treatment plant. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation of small-scale waste water treatment plant. ESA-DBP
Functional Unit	person·year
Functional Unit Explanation	The functional unit chosen is the treatment of one persons sewage and organic waste during one year. The sewage treatment includes black water and grey water.
Process Type	Gate to grave
Site	WWTP in Horn, Sweden
Sector	Waste treatment
Owner	WWTP in Horn, Sweden
Technical system description	Small waste water treatment process was one of the options considered for a little village Horn in the municipality of Västerås, which is a small, planned village of 200 inhabitants situated in a rural area in central Sweden. The other options were: liquid composting continuous process and liquid composting batch process. Excerpt from the report, see 'Publication': In the (...) WWTP, all wastewater is treated in a small wastewater treatment plant consisting of mechanical, biological and chemical steps. The organic kitchen waste is treated separately in a common drum compost. After storage the sludge is spread on agricultural land while the compost is used in the residents' gardens. (...) In the households water saving toilets are installed with two different volumes: small flush (urine) 2 litres, and big flush (faeces) 4 litres. It is estimated, using the assumptions above that one person uses 14 litres of water per day for flushing. The treatment includes a biological and a chemical step. It is a batch process with two modules which are supplied from one receiving tank. Each of the modules goes through a cycle of five phases; filling, aeration, sedimentation, emptying and pausing. Excess sludge is pumped to the sludge tank. Iron chloride (PIX 111) is added as a precipitation chemical and oxygen for the biological process is supplied by two aerators. The whole treatment process is regulated by a computer (not included in the analysis). (...) Before the treated wastewater is released to the recipient it is disinfected with ultraviolet light to destroy pathogens. The water is led through a contact basin where UV lamps are installed. As a source of UV radiation mercury lamps are used. The electricity demand of the disinfection is included in the analysis but not 43 the construction of the UV-basin nor is the production and disposal of mercury lamps, hereby assuming that no leakage of mercury will occur. (...) Kitchen waste is ground and composted in a local drum compost. The mixture is aerated and mixed in the rotating drum. To achieve a favourable carbon-nitrogen quota wooden chips should be added. Most of the organic material is converted to carbon dioxide and it is assumed that about 20% of the nitrogen is released to the air, half as ammonia and half as nitrogen gas. The drum compost is placed in a building identical to the sewage plant building (included in the analysis). The composted product is stored there until the residents use it in their gardens. (...) The plant is placed in a building (35 m^2) which is included in the analysis. The sludge from the process is pumped to a concrete storage tank (100 m^3). The tank is underground, covered and the sludge is mixed to avoid emissions of NH_3, CH_4 and odour. Sewage sludge is stored up to one year before it is spread on arable land.'' This process is included in the system described in: Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf Other processes in the CPM Database also included in the above publication: Operation of waste water treatment plant with urine and sludge separation . ESA-DBP Operation of the sewage sludge and septage treatment system - local treatment option.

	ESA-DBP Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP Operation of liquid composting continuous system. ESA-DBP Operation of liquid composting batch process. ESA-DBP Operation of large scale waste water treatment plant. ESA-DBP Construction of small-scale waste water treatment plant. ESA-DBP Construction of liquid composting continous system. ESA-DBP Construction of liquid composting batch system. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''The operation of the system concerns first of all the emissions to Lake Freden part of Lake Mälaren. But the operation also has impacts on a larger scale, such as emissions of gaseous pollutants and materials produced in other regions.''
Time Boundary	The data were acquired in 1997 as th e most up-to-date ones. Excerpt from the report, see 'Publication': ''The study is made for a wastewater system in a village planned to be built in one or two years. The components of the sanitary system are assumed to have a life time of 15 to 30 years.''
Geographical Boundary	The study was done for the village Horn, Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': ''Included in the system are the collection, treatment and transportation of waste and wastewater, and the spreading of nutrients on agricultural land. The production of chemicals and other types of 35 materials needed are included.The study includes the handling of wastewater and organic (compostable) kitchen waste, but not other types of waste such as glass, plastics, paper or metals. Furthermore distribution and treatment of drinking water and collection of stormwater are not included in the study. These will be the same for the two alternatives and will not contribute to differences in the comparison.'' Operating the computer and transportation of the material are not included in the analysis.
Allocations	No information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Some of the data delivered by local authorities and some adapted from the other report
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Production of electricity is not included Local authorities provided site-specific data, while data on equipment were provided by suppliers or estimated from existing systems. General data taken from the literature were used for nutrient content of sewage, the production of precipitation chemicals, fertilizers production, diesel consumption and emissions in the spreading of manure, and the production of different materials.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Water	8.14E+03			g	Water	Sweden
	Input	Refined resource	Diesel	2.25E+01			g	Technosphere	Sweden
	Input	Refined resource	Electricity	1.13E+02			kWh	Technosphere	Sweden
	Input	Refined resource	Gas	1.27E+00			g	Technosphere	Sweden
	Input	Refined resource	Oil	1.17E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Rock salt	2.26E+03			g	Technosphere	Sweden
	Input	Resource	*Fe	2.32E+03			g	Technosphere	Sweden
	Input	Resource	Iron ore	5.60E+03			g	Ground	Sweden
	Input	Resource	Lime	1.09E+00			g	Technosphere	Sweden

	Input	Resource	Na2CO3-	6.00E-01			g	Technosphere	Sweden
Notes: Useful flow to agriculture	Output	By-product	N-tot	9.80E+02			g	Ground	Sweden
Notes: Useful flow to agriculture	Output	By-product	P-tot	7.30E+02			g	Ground	Sweden
	Output	Emission	BOD	9.00E+02			g	Water	Sweden
	Output	Emission	Cd	3.30E-08			g	Water	Sweden
	Output	Emission	CH4	1.00E-02			g	Air	Sweden
	Output	Emission	Co	4.00E-02			g	Water	Sweden
	Output	Emission	CO	7.66E+00			g	Air	Sweden
	Output	Emission	CO2	1.97E+03			g	Air	Sweden
	Output	Emission	Cr	9.00E-02			g	Water	Sweden
	Output	Emission	Cu	2.00E-02			g	Water	Sweden
	Output	Emission	Fe	4.98E-06			g	Water	Sweden
	Output	Emission	HC	7.20E-01			g	Air	Sweden
	Output	Emission	N2O	6.00E-02			g	Air	Sweden
	Output	Emission	NH3	1.30E+02			g	Air	Sweden
	Output	Emission	Ni	4.00E-02			g	Water	Sweden
	Output	Emission	NOx	3.00E+01			g	Air	Sweden
	Output	Emission	N-tot	3.70E+03			g	Water	Sweden
	Output	Emission	PAH	3.70E-05			g	Ground	Sweden
	Output	Emission	Particles	8.60E-01			g	Air	Sweden
	Output	Emission	Pb	1.00E-02			g	Water	Sweden
	Output	Emission	P-tot	4.00E+01			g	Water	Sweden
	Output	Emission	SO2	2.18E+00			g	Air	Sweden
	Output	Emission	VOC	1.77E+00			g	Air	Sweden
	Output	Emission	Zn	1.73E-06			g	Water	Sweden
	Output	Residue	Hazardous waste	5.50E+00			g	Technosphere	Sweden
	Output	Residue	Waste	1.73E+02			g	Technosphere	Sweden
	Output	Residue	Wood	3.60E+03			g	Technosphere	Sweden

About Inventory	
Publication	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf
Intended User	LCA practitioner, Waste Water Treatment System Specialist
General Purpose	Excerpt from the report, see 'Publication': ''The LCAs were performed on planned wastewater systems in areas within three Swedish minicipalities; Luleå, Västerås and Strömstad. Apart from the case studies a literature study of substitutability of nutrients in sewage compared to artificial fertilizers was performed.''
Detailed Purpose	Horn was chosen as an example of small community. Excerpt from the report, see 'Publication': ''This study has been made in order to find out the environmental consequences of two alternatives for the handling of organic waste and sewage for the village of Horn. (...) The question the LCA should answer is: Which technical solution will give the least environmental impact, to treat the toilet and organic kitchen waste by liquid-composting or to treat the wastewater in a small sewage plant and the compostable kitchen waste in a drum compost''
Commissioner	Swedish Environmental Agency - .
Practitioner	Lundin, Margareta - .
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).

Notes	NB: The results from the project were also used in the following paper: Lundin M., Bengtsson M., Molander S. (2000). Life Cycle Assessment of Wastewater Systems: Influence of System Boundaries and Scale on Calculated Environmental Loads. Technical Environmental Planning, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf

SPINE LCI dataset: Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP
Functional Unit	1 m3 of handled raw sewage sludge
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''the functional unit chosen is the handling of one m^3 of raw sewage sludge. The handling include thickening, stabilisation, transports and spreading to agricultural land. (A rough estimation is that 1 m^3 sludge correspond to 2 person equivalents).''
Process Type	Gate to grave
Site	Koster islands, Strömstad, Sweden
Sector	Waste treatment
Owner	Koster islands, Strömstad, Sweden
Technical system description	Central treatment of sewage sludge and septage is an option for the Koster islands in the municipality of Strömstad. Excerpt from the report, see 'Publication': ''The municipality of Strömstad is planning to build a common sewer system for the two islands, increase the capacity of the sewers and construct a wastewater treatment plant. The sludge from the sewage plant and the septage from the individual septic tanks will be treated either locally on the islands or transported to Strömstad. The estimated future capacity is that 400 persons on average will be connected to the planned sewage plant and about 300 septic tanks (corresponding to an average of 1000 persons) will be emptied and the septage treated. It is estimated that the amount of sludge from the central septic tank will increase to 200 m^3 per year when the sewage plant is built.'' The general flow starts with treatment of supernatant which is followed by sludge transportation to the thickening mechanism. In parallel septage is prepared and transported to this mechanism as well. After this step liquid compost is transported to Strömstad Waste Water Treatment Plant where is dewatered, stored and then spread near Strömstad area. Excerpt from the report, see 'Publication': ''The sewage plant chosen is a rotating biological contactor from Klargester called Biodisc. The Biodisc, consist of two discs, one will be operating during winters and two during summers. (...) After treatment the treated wastewater will be led to a system of ditches and wetlands and the water can be used for irrigation during the summer. The wastewater is first led to a primary settlement and then to the biological step. The biological treatment consist of the rotating discs where the wastewater is aerated. On the large areas of the discs biomass is grown. Suspended biomass is led to the primary settlement and to the final settlement. Excess sludge is pumped from the final settlement and transported to a storage tank. Iron chloride is added as a precipitation chemical by a dosage pump. The septage is collected by trucks during two weeks before the summer season. The septic tanks have a volume of ca 4m^3 and are emptied every second year which means that 600 m^3 sludge is collected every year. The dry solid content (DS) is low, about 1%. The pumper truck has a volume of 12m^3. According to SNV 87:6 a well-designed and maintained septic tank can separate the suspended material by ca 70 % but the reduction of nutrients is low; 10-20%. (...) Thickening is the procedure used to increase the solid content of the sludge by removing the liquid fraction. Paper and grit is separated from the septage before thickening by a screen bar and collected together with the sewage grit in a container. (...) The thickener consist of a rotating drum. Polymer is added to the raw sludge which is led through the drum by the rotation and the slope of the drum and the water is drained through a sieve cloth. The sieve cloth is not included in the LCA. The thickened sludge is led to a storage tank and the liquid fraction is returned to the sewage plant. It is estimated that all of the phosphorus and BOD is bound to the sludge while half of the nitrogen content in

	septage and sludge is dissolved to the liquid and hence is returned to the sewage plant. The sludge is thickened to a DS-content of 5%. (...) In the central treatment alternative the sludge is thickened as described above before transportation to a central treatment plant in Strömstad. There the sludge is received and mixed with the Strömstad sewage sludge before it is dewatered in a centrifuge. The Strömstad sewage plant is operated as an extended aeration process which give some stabilisation. The external sludge from Koster is not subjected to any stabilisation other than storage which means that the risk of contamination from the sludge is higher than in the first alternative. The supernatant from the dewatering is led to the biological treatment. As in the thickening process it is assumed that all of the phosphorus and BOD is bound to the sludge while half of the nitrogen is dissolved to the liquid and returned to the Strömstad sewage plant. The supernatant correspond to a very low percentage of the total flow to the treatment plant. Therefor it is assumed that the electricity demand due to the treatment of the supernatant is negligible. After the centrifugation (where polymer is added) the sludge has a DS-content of 15%. All of the sludge is assumed to be spread on agricultural land on a average distance of 25 km from Strömstad.'' This process is included in the system described in: Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf Other processes in the CPM Database also included in the above publication: Operation of waste water treatment plant with urine and sludge separation . ESA-DBP Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP Operation of small-scale waste water treatment plant. ESA-DBP Operation of liquid composting continuous system. ESA-DBP Operation of liquid composting batch process. ESA-DBP Operation of large scale waste water treatment plant. ESA-DBP Construction of small-scale waste water treatment plant. ESA-DBP Construction of liquid composting continous system. ESA-DBP Construction of liquid composting batch system. ESA-DBP

System Boundaries	
Nature Boundary	The sludge is collected in the households and processed. The output is mainly compost which can be useful in agriculture. The system studied can also have impacts on a larger scale such as emissions of gaseous pollutants, use of energy and chemicals produced in other regions e.g. phosphorus mining.
Time Boundary	The data were acquired in 1997 as the most up-to-date ones. The sanitary system is planned to be built in 1998 and will operate for some decades.
Geographical Boundary	Excerpt from the report, see 'Publication': ''The operation of the wastewater system is limited to the islands of Koster and the city of Strömstad with its close surroundings. However the contaminants from the system can have effects on a larger area.''
Other Boundaries	Excerpt from the report, see 'Publication': ''The study only includes the treatment of sewage sludge and septage, not other types of solid waste. The wastewater treatment is partly included, namely the part that involves the 63 liquid fraction which remains after thickening (supernatant) and not the ordinary treatment of wastewater. Another limitation is that the LCA only includes the operation of the system, not the construction. The production of electricity is included in the analysis and is calculated as average Swedish electricity. The production of polymer and avoided production of fertiliser are also included. The use of fossil fuels such as gas, oil and coal are considered in the system but not the refining or extraction of the resources. (...) The estimated future capacity is that 400 persons on average will be connected to the planned sewage plant and about 300 septic tanks (corresponding to an average of 1000 persons) will be emptied and the septage treated. It is estimated that the amount of sludge from the central septic tank will increase to 200 m^3 per year when the sewage plant is built.'' NB: the results presented in CPM do not include electricity nor avoided production of fertiliser.
Allocations	No information about the allocation process.
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'

Method	Unknown
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Excerpt from the report, see 'Publication': ''Data for the present system and future plans for sewage and sludge handling, transportation and distances have been supplied by the Technical Office in Strömstad (Tysklind, 1996). For the operation of the Biorotor plant, the liquid-composting reactor and the thickener, data from the different suppliers have been used (Klargester, Alfa-Laval and LR Miljö). Literature data for nutrients content in sewage, septage and sludge have been used together with sewage plant and septic tank performances from similar equipment when estimating the impact on receiving waters.''

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Diesel	6.60E+00			kWh	Technosphere	Sweden
	Input	Refined resource	Electricity	1.90E+00			kWh	Technosphere	Sweden
	Input	Refined resource	Oil	1.36E+00			kWh	Technosphere	Sweden
	Input	Resource	Gas	1.02E+00			kWh	Technosphere	Sweden
	Input	Resource	Raw sludge	2.50E-01			m3	Technosphere	Sweden
	Input	Resource	Septage	7.50E-01			m3	Technosphere	Sweden
	Output	By-product	N-tot	5.40E+02			g	Ground	Sweden
	Output	By-product	P-tot	4.90E+02			g	Ground	Sweden
	Output	Emission	CH4	1.00E-02			g	Air	Sweden
	Output	Emission	CO	8.39E+00			g	Air	Sweden
	Output	Emission	CO2	2.08E+03			g	Air	Sweden
	Output	Emission	HC	9.90E-01			g	Air	Sweden
	Output	Emission	N2O	6.00E-02			g	Air	Sweden
	Output	Emission	NH3	6.00E+01			g	Air	Sweden
	Output	Emission	NOx	3.26E+01			g	Air	Sweden
	Output	Emission	N-tot	6.20E+02			g	Water	Sweden
	Output	Emission	Oil	2.64E-04			g	Water	Sweden
	Output	Emission	Particles	1.20E+00			g	Air	Sweden
	Output	Emission	Phenol	4.00E-06			g	Water	Sweden
	Output	Emission	Rejectw	9.20E-01			g	Water	Sweden
	Output	Emission	SO2	3.45E+00			g	Air	Sweden
	Output	Emission	VOC	1.67E+00			g	Air	Sweden
	Output	Product	Treated sludge	1.00E+00			m3	Other	

About Inventory

Publication	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf
Intended User	LCA practitioner, Waste Water Treatment System Specialist
General Purpose	Investigating the two different ways to treat sewage sludge and septage through a LCA perspective.
Detailed Purpose	Excerpt from the report: ''The study has been made in order to find out the environmental consequences of two alternatives for the handling of sewage sludge and septage for the islands of Koster. The question the LCA should answer is: Which technical solution will give the least environmental impact, to thicken the sludge, stabilise it on Koster and use it as fertiliser locally or to thicken the sludge, transport it to the mainland and the central wastewater treatment plant in Strömstad, de-water the sludge and spread the sludge on agricultural land around Strömstad?''
Commissioner	Swedish Environmental Agency - .
Practitioner	Lundin, Margareta - .
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis.

	Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP
Functional Unit	1 m3 of handled raw sewage sludge
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''the functional unit chosen is the handling of one m³ of raw sewage sludge. The handling include thickening, stabilisation, transports and spreading to agricultural land. (A rough estimation is that 1 m³ sludge correspond to 2 person equivalents).''
Process Type	Gate to grave
Site	
Sector	Waste treatment
Owner	
Technical system description	Local treatment of sewage sludge and septage is an option for the Koster islands in the municipality of Strömstad. Excerpt from the report, see 'Publication': ''The municipality of Strömstad is planning to build a common sewer system for the two islands, increase the capacity of the sewers and construct a wastewater treatment plant. The sludge from the sewage plant and the septage from the individual septic tanks will be treated either locally on the islands or transported to Strömstad. The estimated future capacity is that 400 persons on average will be connected to the planned sewage plant and about 300 septic tanks (corresponding to an average of 1000 persons) will be emptied and the septage treated. It is estimated that the amount of sludge from the central septic tank will increase to 200 m³ per year when the sewage plant is built.'' The general flow starts with treatment of supernatant which is followed by sludge transportation to the thickening mechanism. In parallel septage is prepared and transported to this mechanism as well. After this step liquid compost is stored and then spread in Koster areas. Excerpt from the report, see 'Publication': ''The sewage plant chosen is a rotating biological contactor from Klargester called Biodisc. The Biodisc, consist of two discs, one will be operating during winters and two during summers. (...) After treatment the treated wastewater will be led to a system of ditches and wetlands and the water can be used for irrigation during the summer. The wastewater is first led to a primary settlement and then to the biological step. The biological treatment consist of the rotating discs where the wastewater is aerated. On the large areas of the discs biomass is grown. Suspended biomass is led to the primary settlement and to the final settlement. Excess sludge is pumped from the final settlement and transported to a storage tank. Iron chloride is added as a precipitation chemical by a dosage pump. The septage is collected by trucks during two weeks before the summer season. The septic

	tanks have a volume of ca 4m³ and are emptied every second year which means that 600 m³ sludge is collected every year. The dry solid content (DS) is low, about 1%. The pumper truck has a volume of 12m³. According to SNV 87:6 a well-designed and maintained septic tank can separate the suspended material by ca 70 % but the reduction of nutrients is low; 10-20%. (...) Thickening is the procedure used to increase the solid content of the sludge by removing the liquid fraction. Paper and grit is separated from the septage before thickening by a screen bar and collected together with the sewage grit in a container. (...) The thickener consist of a rotating drum. Polymer is added to the raw sludge which is led through the drum by the rotation and the slope of the drum and the water is drained through a sieve cloth. The sieve cloth is not included in the LCA. The thickened sludge is led to a storage tank and the liquid fraction is returned to the sewage plant. It is estimated that all of the phosphorus and BOD is bound to the sludge while half of the nitrogen content in septage and sludge is dissolved to the liquid and hence is returned to the sewage plant. The sludge is thickened to a DS-content of 5%. (...) The raw sludge has to be stabilised to reduce pathogens and eliminate odours when the sludge is to be applied on land. In the local alternative the sludge is assumed to be stabilised in a liquid-compost after thickening. The liquid composted sludge is stored and then transported to agricultural land, in average 2 km from the sewage plant and spread by manure spreaders.'' This process is included in the system described in: Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf Other processes in the CPM Database also included in the above publication: Operation of waste water treatment plant with urine and sludge separation . ESA-DBP Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP Operation of small-scale waste water treatment plant. ESA-DBP Operation of liquid composting continuous system. ESA-DBP Operation of liquid composting batch process. ESA-DBP Operation of large scale waste water treatment plant. ESA-DBP Construction of small-scale waste water treatment plant. ESA-DBP Construction of liquid composting continous system. ESA-DBP Construction of liquid composting batch system. ESA-DBP

System Boundaries

Nature Boundary	The sludge is collected in the households and processed. The output is mainly compost which can be useful in agriculture. The system studied can also have impacts on a larger scale such as emissions of gaseous pollutants, use of energy and chemicals produced in other regions e.g. phosphorus mining.
Time Boundary	The data were acquired in 1997 as the most up-to-date ones. The sanitary system is planned to be built in 1998 and will operate for some decades.
Geographical Boundary	Excerpt from the report, see 'Publication': ''The operation of the wastewater system is limited to the islands of Koster and the city of Strömstad with its close surroundings. However the contaminants from the system can have effects on a larger area.''
Other Boundaries	Excerpt from the report, see 'Publication': ''The study only includes the treatment of sewage sludge and septage, not other types of solid waste. The wastewater treatment is partly included, namely the part that involves the 63 liquid fraction which remains after thickening (supernatant) and not the ordinary treatment of wastewater. Another limitation is that the LCA only includes the operation of the system, not the construction. The production of electricity is included in the analysis and is calculated as average Swedish electricity. The production of polymer and avoided production of fertiliser are also included. The use of fossil fuels such as gas, oil and coal are considered in the system but not the refining or extraction of the resources. (...) The estimated future capacity is that 400 persons on average will be connected to the planned sewage plant and about 300 septic tanks (corresponding to an average of 1000 persons) will be emptied and the septage treated. It is estimated that the amount of sludge from the central septic tank will increase to 200 m³ per year when the sewage plant is built.'' NB: the results presented in CPM do not include electricity nor avoided production of fertiliser.
Allocations	No information about the allocation process.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Excerpt from the report, see 'Publication': ''Data for the present system and future plans for sewage and sludge handling, transportation and distances have been supplied by the Technical Office in Strömstad (Tysklind, 1996). For the operation of the Biorotor plant, the liquid-composting reactor and the thickener, data from the different suppliers have been used (Klargester, Alfa-Laval and LR Miljö). Literature data for nutrients content in sewage, septage and sludge have been used together with sewage plant and septic tank performances from similar equipment when estimating the impact on receiving waters.''

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Diesel	2.97E+00			kWh	Technosphere	Sweden
	Input	Refined resource	Electricity	8.60E+00			kWh	Technosphere	Sweden
	Input	Resource	Gas	4.40E-01			kWh	Technosphere	Sweden
	Input	Resource	Oil	3.60E-01			kWh	Technosphere	Sweden
	Input	Resource	Peat	8.80E-01			l	Technosphere	Sweden
	Input	Resource	Raw sludge	2.50E-01			m3	Technosphere	Sweden
	Input	Resource	Septage	7.50E-01			m3	Technosphere	Sweden
	Output	By-product	N-tot	8.60E+02			g	Ground	Sweden
	Output	By-product	P-tot	4.90E+02			g	Ground	Sweden
	Output	Emission	CH4	1.00E-02			g	Air	Sweden
	Output	Emission	CO	3.58E+00			g	Air	Sweden
	Output	Emission	CO2	8.79E+02			g	Air	Sweden
	Output	Emission	COD	3.30E-04			g	Water	Sweden
	Output	Emission	HC	8.00E-02			g	Air	Sweden
	Output	Emission	N2O	4.00E-02			g	Air	Sweden
	Output	Emission	NH3	9.50E+01			g	Air	Sweden
	Output	Emission	NOx	1.43E+01			g	Air	Sweden
	Output	Emission	N-tot	3.80E+02			g	Water	Sweden
	Output	Emission	Oil	1.10E-04			g	Water	Sweden
	Output	Emission	PAH	2.50E-05			g	Ground	Sweden
	Output	Emission	Particles	9.00E-02			g	Air	Sweden
	Output	Emission	Phenol	2.00E-06			g	Water	Sweden
	Output	Emission	Rejectw	7.50E-01			m3	Water	Sweden
	Output	Emission	SO2	1.90E-01			g	Air	Sweden
	Output	Emission	VOC	1.18E+00			g	Air	Sweden
	Output	Product	Treated sludge	1.00E+00			m3	Other	Sweden

About Inventory

Publication	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf
Intended User	LCA practitioner, Waste Water Treatment System Specialist
General Purpose	Investigating the two different ways to treat sewage sludge and septage through a LCA perspective.
Detailed Purpose	Excerpt from the report: ''The study has been made in order to find out the environmental consequences of two alternatives for the handling of sewage sludge and septage for the islands of Koster. The question the LCA should answer is: Which technical solution will give the least environmental impact, to thicken the sludge, stabilise it on Koster and use it as fertiliser locally or to thicken the sludge, transport it to the mainland and the central wastewater treatment plant in Strömstad, de-water the sludge and spread the sludge on agricultural land around Strömstad?''

Commissioner	Swedish Environmental Agency - .
Practitioner	Lundin, Margareta - .
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Operation of waste water treatment plant with urine and sludge separation . ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation of waste water treatment plant with urine and sludge separation . ESA-DBP
Functional Unit	person·year
Functional Unit Explanation	These flows were normalized to the functional unit which is treatment of the sewage from one person-equivalent during one year. The person-equivalent is a fictitious person who spends all his or her time in Kronan.
Process Type	Gate to grave
Site	Building area 'Kronan', Luleå
Sector	Waste treatment
Owner	Building area 'Kronan', Luleå
Technical system description	Urine separation system is an alternative solution for a conventional waste water treatment plant. The study was performed for Luleå, a city in Northern Sweden. The system was designed for the area that accomodates 2700 inhabitants and provides workspace for 1000 people. The urine separation system requires the separation toilets to be installed. The urine water will be taken care of separately and stored in tanks. After seasonal storage of 6 months, the urine would be transported approximately 8 km and spread as liquid fertilizer. Feaces and grey water would undergo the same WWTP process as in the conventional alternative. Also in this case the sludge would be used for fertilization. The sewage system in Kronan is not built yet and according to the plans, it will be connected to the existing system in Luleå and the existing WWTP at Uddebo. The following assumptions were done: Excerpt from the report, see 'Publication': ''1. The Kronan housing area is built and all the inhabitants have moved in. 2. The Uddebo WWTP is extended with a step for biological treatment, and this new step is running in steady state. 3. Systems and routines for bringing the major part of the urine and the sludge to agricultural land are established.''

	This process is included in the system described in: Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf Other processes in the CPM Database also included in the above publication: Operation of the sewage sludge and septage treatment system - local treatment option. ESA-DBP Operation of the sewage sludge and septage treatment system - central treatment option. ESA-DBP Operation of small-scale waste water treatment plant. ESA-DBP Operation of liquid composting continuous system. ESA-DBP Operation of liquid composting batch process. ESA-DBP Operation of large scale waste water treatment plant. ESA-DBP Construction of small-scale waste water treatment plant. ESA-DBP Construction of liquid composting continous system. ESA-DBP Construction of liquid composting batch system. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) emissions to air, emissions to water, and waste generation.
Time Boundary	The data were acquired in 1997 as the most up-to-date ones. It is assumed that the results should be valid for at least 10 years.
Geographical Boundary	The study was done for Luleå, Sweden.
Other Boundaries	The LCA base model included the collection, treatment, and transportation of wastewater as well as the production of chemicals and other materials required to operate the system. Excerpt from the report, see 'Publication': ''The heating of water has not been included in the analysis since it has been assumed that there will be no difference between the alternatives in the consumption of hot water. For the sake of making a complete description of the technical systems and an analysis of the environmental impact of these systems, it might have been included. In the analysis only the environmental impacts the households cause via the sanitary systems have been regarded. Other environmental impacts of the households have been regarded as irrelevant in this study. The treatment of storm water has not been included in the study. In both alternatives, storm water will be taken care of separately and, consquently, it will not affect the flows of sewage and urine.''
Allocations	No information about the allocation process in the report.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data delivered by local authorities
Literature Reference	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf
Notes	Excerpt from the report, see 'Publication': ''Most data used in the study are of a site-specific character. These have been provided by the local authorities in Luleå, and should have high accuracy and relevance. Nonetheless, many assumptions have been made about the performance of the systems studied.''

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Resource	*Fe	1.15E+03			g	Technosphere	Sweden
	Input	Resource	*Raw phosphate	-3.99E+03			g	Technosphere	Sweden
	Input	Resource	Bauxite	4.50E-03			g	Ground	Sweden
	Input	Resource	Bio fuel	1.81E+03			g	Technosphere	Sweden
	Input	Resource	CO2	1.65E+03			g	Technosphere	Sweden
	Input	Resource	Copper ore	7.09E+01			g	Ground	Sweden

	Input	Resource	Diesel	1.33E+01			kWh	Technosphere	Sweden
	Input	Resource	Gas	-2.40E+01			kWh	Technosphere	Sweden
	Input	Resource	H2SO4	-3.69E+03			g	Technosphere	Sweden
	Input	Resource	Iron ore	2.29E+00			g	Ground	Sweden
Notes: Useful flow to agriculture	Input	Resource	Land use	3.12E-01			m2	Ground	Sweden
	Input	Resource	Lead ore	8.19E-01			g	Technosphere	Sweden
	Input	Resource	Limestone	3.69E+03			g	Technosphere	Sweden
	Input	Resource	Na2CO3-	4.63E-01			g	Technosphere	Sweden
	Input	Resource	NaCl	1.74E+03			g	Technosphere	Sweden
	Input	Resource	NaOH	1.81E-01			g	Technosphere	Sweden
	Input	Resource	NH3	5.38E-01			g	Technosphere	Sweden
	Input	Resource	Nitric acid	2.61E-01			g	Technosphere	Sweden
	Input	Resource	Oil	2.11E+01			kWh	Technosphere	Sweden
	Input	Resource	Uranium ore	4.15E+01			g	Technosphere	Sweden
	Input	Resource	Wood	1.60E-01			g	Technosphere	Sweden
Notes: Useful flow to agriculture	Output	By-product	Biogas	5.87E+01			kWh	Technosphere	Sweden
	Output	Emission	BOD	8.75E+02			g	Water	Sweden
	Output	Emission	CH4	2.14E-02			g	Air	Sweden
	Output	Emission	Cl2	5.00E-04			g	Air	Sweden
	Output	Emission	CO	1.74E+01			g	Air	Sweden
	Output	Emission	CO2	6.87E+02			g	Air	Sweden
	Output	Emission	COD	-1.26E-02			g	Water	Sweden
	Output	Emission	HC	2.48E+00			g	Air	Sweden
	Output	Emission	N2O	-3.96E+01			g	Air	Sweden
	Output	Emission	NH3	8.41E+02			g	Air	Sweden
	Output	Emission	NH4-N	-3.23E+01			g	Water	Sweden
	Output	Emission	NOx	5.20E+01			g	Air	Sweden
	Output	Emission	N-tot	4.91E+02			g	Water	Sweden
	Output	Emission	Oil	4.30E-03			g	Water	Sweden
	Output	Emission	Particles	4.20E+00			g	Air	Sweden
	Output	Emission	Phenol	1.00E-04			g	Water	Sweden
	Output	Emission	P-tot	1.70E+01			g	Water	Sweden
	Output	Emission	SO2	4.06E+00			g	Air	Sweden
	Output	Emission	VOC	2.56E+00			g	Air	Sweden
	Output	Residue	Ashes	-8.00E-02			g	Technosphere	Sweden
	Output	Residue	Building waste	2.27E+00			g	Technosphere	Sweden
	Output	Residue	Gypsum and heavy metals	-5.96E+03			g	Technosphere	Sweden
	Output	Residue	Hazardous waste	4.23E+00			g	Technosphere	Sweden
	Output	Residue	Highly active rad ac waste	1.51E+00			g	Technosphere	Sweden
	Output	Residue	Low active rad ac waste	9.00E-04			g	Technosphere	Sweden
	Output	Residue	Mineral waste	3.54E+02			g	Technosphere	Sweden
	Output	Residue	Other rest products	3.40E+03			g	Technosphere	Sweden
	Output	Residue	Radioactivity	3.41E+03			kBq	Technosphere	Sweden
	Output	Residue	Waste	1.34E+02			g	Technosphere	Sweden

About Inventory

Publication	Bengtsson M., Lundin M., Molander S. (1997). Life Cycle Assessment of Wastewater Systems. Case studies of Conventional Treatment, Urine Sorting and Liquid Composting in Three Swedish Municipalities. Technical Environmental Planning, Report 1997:9, ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/TEP_1997--9.pdf
Intended User	LCA practitioner, Waste Water Treatment System Specialist
General Purpose	Excerpt from the report, see 'Publication': ''The LCAs were performed on planned wastewater systems in areas within three Swedish minicipalities; Luleå, Västerås and Strömstad. Apart from the case studies a literature study of substitutability of nutriens in sewage compared to artificial fertilizers was performed.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The study has been made in order to find out the environmental consequences of two different sewage treatment alternatives for the projected housing area Kronan in the city of Luleå.(...) The major difference between the alternatives studied is that in one case the urine will be taken care of separately, while in the other the urine will be treated together with the rest of the sewage in a conventional way''

Commissioner	Swedish Environmental Agency - .
Practitioner	Bengtsson, Magnus - TEP, Chalmers University of Technology.
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The results from the project were also used in the following paper: Lundin M., Bengtsson M., Molander S. (2000). Life Cycle Assessment of Wastewater Systems: Influence of System Boundaries and Scale on Calculated Environmental Loads. Technical Environmental Planning, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/TEP_1997--9.pdf

SPINE LCI dataset: Operation on desiccant cooling system - a technology in air conditioning. ESA-DBP

Administrative	
Finished	Y
Date Completed	2007
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation on desiccant cooling system - a technology in air conditioning. ESA-DBP
Functional Unit	1 year of operation of desiccant cooling system
Functional Unit Explanation	Energy use of disiccant cooling system operated for 1 year. Operational time is 24 hours per day.
Process Type	Gate to gate
Site	Unknown
Sector	Goods and services for households
Owner	Unknown
Technical system description	In the study the annual operating energy use during the use phase is considered. Excerpt from the report, see 'Publication': ''Desiccant cooling is an alternative technology for all-air air conditioning systems. This technique, in purpose to cool the ventilating airflow, is operated by heat and water. Hence, no ordinary refrigerant is needed. Consequently, the environmental impact due to refrigerant leakage is eliminated. Moreover, no electricity is needed for cooling the air by desiccant cooling, except of for transporting the ventilating air to and from the premises. (...) In this paper dessicant cooling refer to the combination of desiccant dehumidification and evaporative cooling for air conditioning. There are several possible ways in which such systems can be designed and there are various types of desiccant dehumidifiers that can be used for these applications. In this case, the desiccant dehumidifier concerned is a rotary dehumidifier, a desiccant wheel. The desiccant cooling system configurations studied here are not suited for controlling the indoor air humidity. The supply air humidity ratio will vary depending on the mode of operation as well as the control strategy applied. (...) In the moderately dry and cool ambient climates considered in this paper, air-conditioning primarily is used to control the indoor air temperature.''

	The main components of a desiccant cooling air handling unit are: dehumidifier, heater (regeneration coil), heat exchanger and evaporative coolers. The task of the system is ''to cool or heat a ventilating airflow of 5m3/s (100% outdoor air) to a constant supply air temperature of 17°C. The exhaust air temperature is 24°C and the exhaust air humidity ratio is 0.007 kg/kg higher than the supply air humidity ratio due to internal heat loads. Both air handling units are designed for a maximum specific fan power (SFP) of 2.4 kW/(m3/s), and the operational time is 24 hours per day during a whole year. The local climate concerned is hourly measured weather data for Stokholm, Sweden 1990. The year 1990 is chosen out of hourly measured weather data for period 1983-1992 because the number of hours with ambient air temperatures above 17°C this year is closest to the 10-year mean value. (...) The component performances are: - The supply and exhaust evaporative coolers' saturation efficiency is 80% - The sensible heat exchanger's temperature efficiency is 70% - The performance of the desiccant wheel is equivalent to a commercialy available component having a face velocity of 2.5 m/s and a rotor depth of 0.2 m. The vapour compression air-cooling process is modelled to be performed by a cooling coil with a constant surface temperature of 100°C. Graphically on a psychometric chart, in case of a wet (sensible or latent) cooling process, this means that the ambient air condition will change in the direction towards the air condition 10°C/100% RH. The evaporating temperature of the refrigerant is 15K lower than the coil surface temperature (-5°C). The condensing temperature is 15K higher than the actual ambient air temperature. Finally, the electricity use by the compressor for cooling the air is calculated hour by hour with a total Carnot efficiency of 0.5. In heating mode, a heat exchanger with the same temperature efficiency as in case of the desiccant cooling system is presumed. Consequently, the vapour compression system requires heat energy when ambient air temperature is below 0°C. The refrigerant is HFC-134a and the charge of the system is 23.5 kg. The annual leakage is assumed 2% of the charge. (...) For the DC air handling unit, electricity is needed for the transportation of the ventilating airflow. The DC-unit requires heat energy in cooling mode for the generation heater, but no heat is required during the cold period of the year due to the combined effect of heat recovery by the exchanger and the desiccant wheel. Water is used for the evaporative cooling. (...) The DC-unit consumes ca 103400 kWh of electricity for operating fans. The heat use is 7600 kWh and the water use is 730 m3 for cooling purpose.'' Main assumptions made for this study are (NB:based on the comparative table): constant airflow, total airflow 5 m3/s, supply air temperature = 17°C, exhaust air temperature = 24°C, operating time - 8760 [hours/year], SFP 2.4 [kW/(m3/s)]. This process is included in the system described in: Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007 Other processes in the CPM Database also included in the above publication: - Bore-hole based air-conditioning system. ESA-DBP - Air-conditioning system. ESA-DBP - Air-and-water air conditioning system. ESA-DBP - All-air air handling unit with a cooling coil and vapour compression chiller with a refrigerant. ESA-DBP - All-air desiccant cooling air handling unit. ESA-DBP - Operation on vapour compression cooling system - a technology in air conditioning. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use and emissions to air from the energy production.
Time Boundary	1995-2000
Geographical Boundary	Sweden
Other Boundaries	Main assumptions made for this study are: constant airflow, total airflow 5m3/s, supply air temperature - 17°C, exhaust air temperature - 24°C, operating time - 8760 [hours/year], SFP 2.4 [kW/(m3/s)]. Excerpt from the report, see 'Publication': ''The task of the system is ''to cool or heat a ventilating airflow of 5m3/s (100% outdoor air) to a constant supply air temperature of 17°C. The exhaust air temperature is 24°C and the exhaust air humidity ratio is 0.007 kg/kg higher than the supply air humidity ratio due to internal heat loads. Both air handling units are designed for a maximum specific fan power (SFP) of 2.4 kW/(m3/s), and the operational time is 24 hours per day during a whole year. The year 1990 is chosen out of hourly measured weather data for Stokholm, Sweden 1990. The year 1990 is chosen out of hourly measured weather data for period 1983-1992 because the number of hours with ambient air temperatures above 17°C this year is closest to the 10-year mean value. (...) The component performances are:

	- The supply and exhaust evaporative coolers' saturation efficiency is 80% - The sensible heat exchanger's temperature efficiency is 70% - The performance of the desiccant wheel is equivalent to a commercialy available component having a face velocity of 2.5 m/s and a rotor depth of 0.2 m.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''(...) Environmental performance is studied by a simplified LCA; therefore, also the quantification of materials can be simplified. (...) The amounts of materials in air handling units and cooling machines were estimated from previously published information or collected from producers of the particular equipment. (...) The cooling loads and annual operating energy were estimated by calculations using the software for heat balance of buildings BV2.''
Literature Reference	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/Heikkila_et_al_2007
Notes	NB: Please note that the data relate only to the annual operating energy use during the user phase.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Resource	Coal in ground	1.71E+04			kg	Ground	Sweden
	Input	Resource	Oil in the ground	7.13E+02			kg	Ground	Sweden
	Output	Emission	CH4	1.60E+00			kg	Air	Sweden
	Output	Emission	CO	8.00E-02			kg	Air	Sweden
	Output	Emission	CO2	4.67E+04			kg	Air	Sweden
Notes: non elementary output	Output	Emission	Dust	2.00E-02			kg	Other	Sweden
	Output	Emission	HFC-134a	5.00E-01			kg	Air	Sweden
	Output	Emission	NMVOC	2.00E-02			kg	Air	Sweden
	Output	Emission	NOx	1.17E+02			kg	Air	Sweden
	Output	Emission	SOx	2.88E+02			kg	Air	Sweden

About Inventory

Publication	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''An objective of this work was that it should lead to an increased knowledge of how to work with environmental issues related to air-conditioning systems for office buildings and to a greater awareness of the environmental loads related to these systems. (...) The objectives of this thesis are to: - describe how the environmental performance of air-conditioning systems can be assessed and evaluated at the design stage. The focus is on the application of existing methods for environmental assessment of these systems. - identify and discuss the major sources of the environmental impacts and give some general recommendations as to how to design air-conditioning systems to improve their environmental performance. - outline possible key performance indicators (KPI) for the environmental performance of the most common types of air-conditioning systems.''
Detailed Purpose	Desiccant cooling is a one of the air conditioning technologies, therefore it was an object of the study.
Commissioner	Unknown - .
Practitioner	Katarina Heikkilä - .

Reviewer	Jan-Olof Dalenbäck, Torbjörn Lindholm, - Building Services Engineering, Energy and Environment, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	For more information and the comparison with the other systems see the report. The reference report is a thesis for the degree of doctor. As a part of it, five papers are included. Paper I relates to the comparison of operational energy in use phase between vapour compression cooling and desiccant cooling systems. The function and other information was taken from the mentioned Paper I. Inventory data come from the main part of the report.

SPINE LCI dataset: Operation on train bearings - train type 'Regina'. ESA-DBP

Administrative	
Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation on train bearings - train type 'Regina'. ESA-DBP
Functional Unit	2 axleboxes with bearings on a distance of 100 000km
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. The functional unit (fu) is here defined as 2 axleboxes with bearings, mounted on a wheel axle in use on its matched Electric Multiple Unit (EMU) during 100 000 km of transport.''
Process Type	Gate to gate
Site	SKF Sverige AB 415 50 Göteborg
Sector	Land transport
Owner	SKF Sverige AB 415 50 Göteborg
Technical system description	The study was done for a a train 'Regina' which is manufactured by Adtranz, today Bombardier Transportation, since the year 2000. In this kind of train pre-lubricated, sealed Tapered Bearing Units, so-called TBUs are used. The Reginas are used on the Swedish West coast, in Mälardalen and in Bergslagen. Excerpt from the study, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. (...) The Regina TBU is named 1639605 C and contains the bearing BT2B 641157 CB. The axlebox has the number 432758. (...) When the trains are in operation the wheel axles and the inner rings of the bearings are rotating with a velocity proportional to the train speed. Because of friction between the bearing components, heat is generated in the axlebox, and at the same time the air outside helps cooling the axlebox. The consequence of the friction is a certain loss of power, and it is influenced by the construction of the bearing, lubrication, radial and axial load, rotational speed etc. The cooling factor is depending on e.g. materials, wind speed and ambient temperature. The calculations used in the study are performed in SKF Galaxy BeaTemp (version 3.1), a

	program that uses the equations published in the SKF General Catalogue to calculate the bearing temperature for which the generated heat is equal to the cooling. The bearing temperature, power loss and basic rating life are then given as outputs from the program. The equations used have been tried and verified by experimental results through several years of testing. The exact conditions for the train bearings could not be modelled in Galaxy, so some of the parameters had to be approximated. To get a realistic picture of the cooling for the actual situation, these parameters were matched to experimental results on bearing temperature from a field experiment with a train similar to X10. It is assumed that the radial load is equally distributed over the bearings on each train car, and that no axial load is present. The calculations are based on the duty mass.'' This process is included in the system described in: Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf Other processes in the CPM Database also included in the above publication: - Operation on train bearings - train type 'X1'. ESA-DBP - Operation on train bearings - train type 'X10'. ESA-DBP - Maintenance of train bearings - train type 'X1'. ESA-DBP - Maintenance of train bearings - train type 'X10'. ESA-DBP - Maintenance of train bearings - train type 'Regina'. ESA-DBP - Use phase of train bearings - train type 'X1'. ESA-DBP - Use phase of train bearings - train type 'X10'. ESA-DBP - Use phase of train bearings - train type 'Regina'. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''The one environmental aspect considered for train bearings in operation is electricity use. (...) Land, water and other types of resource use could not be assessed, due to lack of data.''
Time Boundary	Excerpt from the report, see 'Publication': ''The study is intended to illustrate the present situation, and the qualitative and quantitative information for the main processes are from the year 2001 until today. (NB: the report was written in 2003) Calculations indicated a basic rating life of more than 200 000 hours (...) , i.e. 30 years with a daily running time of 18 hours. It is assumed that the lifetime of the bearings is of the same size as for the trains, and thus can be neglected.''
Geographical Boundary	Excerpt from the report, see 'Publication': ''All the studied trains are in use in Sweden, where most of the maintenance is performed, too.''
Other Boundaries	Excerpt from the report, see 'Publication': ''The mass of passengers is neglected, but corresponds to roughly 10 percent of the duty mass if the train is half-filled. The ambient temperature used in the calculations was 10 degrees centigrade. (...) The total efficiency of the electrical supply system is 81.8 percent for X1 and X10. (...) Noise and vibration were not studied, and other environmental aspects of railway traffic operation were not regarded as being clearly related to the use of bearings. The environmental effects of industrial buildings, production of tools and machines, and the use of human labour are not included. The lifetime of bearings is generally given as basic rating life (L10h), which is 'the life that 90 percent of a sufficiently large group of apparently identical bearings can be expected to attain or exceed'.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''The data has been collected through visits and interviews. (...) Most data are estimates made by responsible personnel at the different sites, as there seldom is any information available, that is detailed enough for the purpose of an LCA. The estimates are combined with data from product data sheets and published LCA literature, to give a realistic approximation of the actual conditions. The electricity use for train bearings in operation was calculated with the computer program SKF Galaxy.''

Literature Reference	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2003--3.pdf
Notes	NB: Please note that the data relate only to the annual operating energy use during the user phase.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity (non-accounted)	6.15E+03			MJ	Technosphere	Sweden
	Output	Emission	CH_4	3.01E+02			g	Air	Sweden
	Output	Emission	CO	1.11E+02			g	Air	Sweden
	Output	Emission	CO_2	4.82E+04			g	Air	Sweden
	Output	Emission	Dust	1.54E+01			g	Air	Sweden
	Output	Emission	N_2O	4.36E+00			g	Air	Sweden
	Output	Emission	NH_3	1.35E+00			g	Air	Sweden
	Output	Emission	NMVOC non-methane HC	1.78E+01			g	Air	Sweden
	Output	Emission	NO_2	9.22E+01			g	Air	Sweden
	Output	Emission	SO_2	7.99E+01			g	Air	Sweden
	Output	Residue	Solid waste	7.99E+01			kg	Technosphere	Sweden

About Inventory

Publication	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this LCA is to investigate the environmental impact of the use-phase for bearings in trains. Three generations of trains, so-called Electrical Multiple Units (EMUs), will be studied, and comparison will be made between processes within the life cycle of the bearings, and between the bearings in the different generations of EMUs.''
Detailed Purpose	Operation of the bearings has a great importance in a use phase so it was necessary to investigate its impact.
Commissioner	SKF Sverige AB - 415 50 Göteborg .
Practitioner	Karl Jonasson - .
Reviewer	Björn Andersson, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report, see 'Publication': ''SKF provides both bearings and bearing housings for trains, called axleboxes, which are mounted in direct connection with the train's wheels to make the wheel axle able to rotate (...). The bearings used for this purpose are in this study referred to as 'train bearings', even though there are other fields of application for bearings in trains (e.g. in the traction system). What type of rolling bearings used for the wheel axle varies according to performance needs and train design, but the function is essentially the same.''

SPINE LCI dataset: Operation on train bearings - train type 'X1'. ESA-DBP

Administrative

Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Operation on train bearings - train type 'X1'. ESA-DBP
Functional Unit	2 axleboxes with bearings on a distance of 100 000km
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. The functional unit (fu) is here defined as 2 axleboxes with bearings, mounted on a wheel axle in use on its matched Electric Multiple Unit (EMU) during 100 000 km of transport.''
Process Type	Gate to gate
Site	SKF Sverige AB 415 50 Göteborg
Sector	Land transport
Owner	SKF Sverige AB 415 50 Göteborg
Technical system description	The study was done for a a train 'X1' which was manufactured by ASEA during the years 1967-1975. In this kind of train an un-sealed Spherical Roller Bearings (SRBs) were used. More than 100 of X1s were produced and most of them are still in use especially in Stokholm area. Excerpt from the study, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. (...) The SRB used in X1-A, X1-B and X10 has the SKF product number 23226 CC/C3W33, and the axleboxes are called 723724, 723721 and 4000850 respectively. (...) When the trains are in operation the wheel axles and the inner rings of the bearings are rotating with a velocity proportional to the train speed. Because of friction between the bearing components, heat is generated in the axlebox, and at the same time the air outside helps cooling the axlebox. The consequence of the friction is a certain loss of power, and it is influenced by the construction of the bearing, lubrication, radial and axial load, rotational speed etc. The cooling factor is depending on e.g. materials, wind speed and ambient temperature. The calculations used in the study are performed in SKF Galaxy BeaTemp (version 3.1), a program that uses the equations published in the SKF General Catalogue to calculate the bearing temperature for which the generated heat is equal to the cooling. The bearing temperature, power loss and basic rating life are then given as outputs from the program. The equations used have been tried and verified by experimental results through several years of testing. The exact conditions for the train bearings could not be modelled in Galaxy, so some of the parameters had to be approximated. To get a realistic picture of the cooling for the actual situation, these parameters were matched to experimental results on bearing temperature from a field experiment with a train similar to X10. It is assumed that the radial load is equally distributed over the bearings on each train car, and that no axial load is present. The calculations are based on the duty mass.'' This process is included in the system described in: Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf Other processes in the CPM Database also included in the above publication: - Operation on train bearings - train type 'X10'. ESA-DBP - Operation on train bearings - train type 'Regina'. ESA-DBP - Maintenance of train bearings - train type 'X1'. ESA-DBP - Maintenance of train bearings - train type 'X10'. ESA-DBP - Maintenance of train bearings - train type 'Regina'. ESA-DBP - Use phase of train bearings - train type 'X1'. ESA-DBP - Use phase of train bearings - train type 'X10'. ESA-DBP - Use phase of train bearings - train type 'Regina'. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''The one environmental aspect considered for train bearings in operation is electricity use. (...) Land, water and other types of resource use could not be assessed, due to lack of data.''
Time Boundary	Excerpt from the report, see 'Publication': ''The study is intended to illustrate the present situation, and the qualitative and quantitative information for the main processes are from the year 2001 until today. (NB: the report was written in 2003) Calculations indicated a basic rating life of more than 200 000 hours (...) , i.e. 30 years with a daily running time of 18 hours. It is assumed that the lifetime of the bearings is of the same size as for the trains, and thus can be neglected.''
Geographical Boundary	Excerpt from the report, see 'Publication': ''All the studied trains are in use in Sweden, where most of the maintenance is performed, too.''
Other Boundaries	Excerpt from the report, see 'Publication': ''The mass of passengers is neglected, but corresponds to roughly 10 percent of the duty mass if the train is half-filled. The ambient temperature used in the calculations was 10 degrees centigrade. (...) The total efficiency of the electrical supply system is 81.8 percent for X1 and X10. (...) Noise and vibration were not studied, and other environmental aspects of railway traffic operation were not regarded as being clearly related to the use of bearings. The environmental effects of industrial buildings, production of tools and machines, and the use of human labour are not included. The lifetime of bearings is generally given as basic rating life (L10h), which is 'the life that 90 percent of a sufficiently large group of apparently identical bearings can be expected to attain or exceed'.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''The data has been collected through visits and interviews. (...) Most data are estimates made by responsible personnel at the different sites, as there seldom is any information available, that is detailed enough for the purpose of an LCA. The estimates are combined with data from product data sheets and published LCA literature, to give a realistic approximation of the actual conditions. The electricity use for train bearings in operation was calculated with the computer program SKF Galaxy.''
Literature Reference	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2003--3.pdf
Notes	NB: Please note that the data relate only to the annual operating energy use during the user phase.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	6.74E+03			MJ	Technosphere	Sweden
	Output	Emission	CH4	3.30E+02			g	Air	Sweden
	Output	Emission	CO	1.21E+02			g	Air	Sweden
	Output	Emission	CO2	5.29E+04			g	Air	Sweden
	Output	Emission	Dust	1.69E+01			g	Air	Sweden
	Output	Emission	N2O	4.79E+00			g	Air	Sweden
	Output	Emission	NH3	1.48E+00			g	Air	Sweden
	Output	Emission	NMVOC non-methane HC	1.96E+01			g	Air	Sweden
	Output	Emission	NO2	1.01E+02			g	Air	Sweden
	Output	Emission	SO2	8.77E+01			g	Air	Sweden
	Output	Residue	Solid waste	8.77E+01			kg	Technosphere	Sweden

About Inventory

Publication	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf

Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this LCA is to investigate the environmental impact of the use-phase for bearings in trains. Three generations of trains, so-called Electrical Multiple Units (EMUs), will be studied, and comparison will be made between processes within the life cycle of the bearings, and between the bearings in the different generations of EMUs.''
Detailed Purpose	Operation of the bearings has a great importance in a use phase so it was necessary to investigate its impact.
Commissioner	SKF Sverige AB - 415 50 Göteborg .
Practitioner	Karl Jonasson - .
Reviewer	Björn Andersson, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report, see 'Publication': ''SKF provides both bearings and bearing housings for trains, called axleboxes, which are mounted in direct connection with the train's wheels to make the wheel axle able to rotate (...). The bearings used for this purpose are in this study referred to as 'train bearings', even though there are other fields of application for bearings in trains (e.g. in the traction system). What type of rolling bearings used for the wheel axle varies according to performance needs and train design, but the function is essentially the same.''

SPINE LCI dataset: Operation on train bearings - train type 'X10'. ESA-DBP

Administrative	
Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation on train bearings - train type 'X10'. ESA-DBP
Functional Unit	2 axleboxes with bearings on a distance of 100 000km
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. The functional unit (fu) is here defined as 2 axleboxes with bearings, mounted on a wheel axle in use on its matched Electric Multiple Unit (EMU) during 100 000 km of transport.''
Process Type	Gate to gate
Site	SKF Sverige AB 415 50 Göteborg
Sector	Land transport
Owner	SKF Sverige AB 415 50 Göteborg
Technical system description	The study was done for a a train 'X10' which was manufactured by ASEA/ABB Traction during the years 1982-1993. In this kind of train an un-sealed Spherical Roller Bearings (SRBs) were used. More than 100 of X10s were produced and most of them are still in use especially in Stokholm, Gotheburg and Skåne area.

	Excerpt from the study, see 'Publication': ''During the 1990s some of the X10s were rebuilt with a different interior, and renamed to X11. These are also included under the designation X10 in this study, as the basic performance is the same. (...) The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. (...) The SRB used in X1-A, X1-B and X10 has the SKF product number 23226 CC/C3W33, and the axleboxes are called 723724, 723721 and 4000850 respectively. (...) When the trains are in operation the wheel axles and the inner rings of the bearings are rotating with a velocity proportional to the train speed. Because of friction between the bearing components, heat is generated in the axlebox, and at the same time the air outside helps cooling the axlebox. The consequence of the friction is a certain loss of power, and it is influenced by the construction of the bearing, lubrication, radial and axial load, rotational speed etc. The cooling factor is depending on e.g. materials, wind speed and ambient temperature. The calculations used in the study are performed in SKF Galaxy BeaTemp (version 3.1), a program that uses the equations published in the SKF General Catalogue to calculate the bearing temperature for which the generated heat is equal to the cooling. The bearing temperature, power loss and basic rating life are then given as outputs from the program. The equations used have been tried and verified by experimental results through several years of testing. The exact conditions for the train bearings could not be modelled in Galaxy, so some of the parameters had to be approximated. To get a realistic picture of the cooling for the actual situation, these parameters were matched to experimental results on bearing temperature from a field experiment with a train similar to X10. It is assumed that the radial load is equally distributed over the bearings on each train car, and that no axial load is present. The calculations are based on the duty mass.'' This process is included in the system described in: Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf Other processes in the CPM Database also included in the above publication: - Operation on train bearings - train type 'X1'. ESA-DBP - Operation on train bearings - train type 'Regina'. ESA-DBP - Maintenance of train bearings - train type 'X1'. ESA-DBP - Maintenance of train bearings - train type 'X10'. ESA-DBP - Maintenance of train bearings - train type 'Regina'. ESA-DBP - Use phase of train bearings - train type 'X1'. ESA-DBP - Use phase of train bearings - train type 'X10'. ESA-DBP - Use phase of train bearings - train type 'Regina'. ESA-DBP

System Boundaries	
Nature Boundary	Excerpt from the report, see 'Publication': ''The one environmental aspect considered for train bearings in operation is electricity use. (...) Land, water and other types of resource use could not be assessed, due to lack of data.''
Time Boundary	Excerpt from the report, see 'Publication': ''The study is intended to illustrate the present situation, and the qualitative and quantitative information for the main processes are from the year 2001 until today. (NB: the report was written in 2003) Calculations indicated a basic rating life of more than 200 000 hours (...) , i.e. 30 years with a daily running time of 18 hours. It is assumed that the lifetime of the bearings is of the same size as for the trains, and thus can be neglected.''
Geographical Boundary	Excerpt from the report, see 'Publication': ''All the studied trains are in use in Sweden, where most of the maintenance is performed, too.''
Other Boundaries	Excerpt from the report, see 'Publication': ''The mass of passengers is neglected, but corresponds to roughly 10 percent of the duty mass if the train is half-filled. The ambient temperature used in the calculations was 10 degrees centigrade. (...) The total efficiency of the electrical supply system is 81.8 percent for X1 and X10. (...) Noise and vibration were not studied, and other environmental aspects of railway traffic operation were not regarded as being clearly related to the use of bearings. The environmental effects of industrial buildings, production of tools and machines, and the use of human labour are not included. (...) The lifetime of train bearings is not included in the study, as this primarily would affect the environmental impact of the production-phase in that a differing number of bearings would be needed to maintain the same function. It is thus included in the production-phase in the comparison with the operation, maintenance and transports processes. The lifetime of bearings is generally given as basic rating life (L10h), which is 'the life that 90 percent of a sufficiently large group of apparently identical bearings can be expected to attain or exceed'.''
Allocations	Unknown

Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''The data has been collected through visits and interviews. (...) Most data are estimates made by responsible personnel at the different sites, as there seldom is any information available, that is detailed enough for the purpose of an LCA. The estimates are combined with data from product data sheets and published LCA literature, to give a realistic approximation of the actual conditions. The electricity use for train bearings in operation was calculated with the computer program SKF Galaxy.''
Literature Reference	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2003--3.pdf
Notes	NB: Please note that the data relate only to the annual operating energy use during the user phase.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Electricity (non-accounted)	8.99E+03			MJ	Technosphere	Sweden
	Output	Emission	CH4	4.40E+02			g	Air	Sweden
	Output	Emission	CO	1.62E+02			g	Air	Sweden
	Output	Emission	CO2	7.05E+04			g	Air	Sweden
	Output	Emission	Dust	2.25E+01			g	Air	Sweden
	Output	Emission	N2O	6.38E+00			g	Air	Sweden
	Output	Emission	NH3	1.98E+00			g	Air	Sweden
	Output	Emission	NMVOC non-methane HC	2.61E+01			g	Air	Sweden
	Output	Emission	NO2	1.35E+02			g	Air	Sweden
	Output	Emission	SO2	1.17E+02			g	Air	Sweden
	Output	Residue	Solid waste	1.17E+02			kg	Technosphere	Sweden

About Inventory

Publication	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this LCA is to investigate the environmental impact of the use-phase for bearings in trains. Three generations of trains, so-called Electrical Multiple Units (EMUs), will be studied, and comparison will be made between processes within the life cycle of the bearings, and between the bearings in the different generations of EMUs.''
Detailed Purpose	Operation of the bearings has a great importance in a use phase so it was necessary to investigate its impact.
Commissioner	SKF Sverige AB - 415 50 Göteborg .
Practitioner	Karl Jonasson - .
Reviewer	Björn Andersson, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).

Notes	Excerpt from the report, see 'Publication': ''SKF provides both bearings and bearing housings for trains, called axleboxes, which are mounted in direct connection with the train's wheels to make the wheel axle able to rotate (...). The bearings used for this purpose are in this study referred to as 'train bearings', even though there are other fields of application for bearings in trains (e.g. in the traction system). What type of rolling bearings used for the wheel axle varies according to performance needs and train design, but the function is essentially the same.''

SPINE LCI dataset: Operation on vapour compression cooling system - a technology in air conditioning. ESA-DBP

Administrative	
Finished	Y
Date Completed	2007
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Operation on vapour compression cooling system - a technology in air conditioning. ESA-DBP
Functional Unit	1 year of operation of vapour compression cooling system
Functional Unit Explanation	Energy use of vapour compression cooling system operated for 1 year. Operational time is 24 hours per day.
Process Type	Gate to gate
Site	Unknown
Sector	Goods and services for households
Owner	Unknown
Technical system description	Vapour compression cooling is a conventional technology in air air conditioning systems. It the paper it was compared to desiccant cooling system based on annual operating energy use during the use phase. Excerpt from the report, see 'Publication': ''One major difference of desiccant cooling compared to vapour compression cooling is that no ordinary refrigerant is needed. This eliminates the direct environmental impact due to unavoidable leakage during normal operation or a break down loss of the whole refrigerant charge. (...) Another difference between desiccant cooling and vapour compression cooling that affect the environmental impact is, that no electricity is needed for cooling the ventilating airflow. Generally, the electrical energy needed for operating the vapour compression system is less than the electrical energy needed for transporting the ventilating air to premises.'' The assumptions are the same as for desiccant cooling (see also: Operation on desiccant cooling system - a technology in air conditioning. ESA-DBP). The main are: constant airflow, total airflow 5 m3/s, supply air temperature = 17°C, exhaust air temperature = 24°C, operating time - 8760 [hours/year], SFP of 2.4 [kW/(m3/s)]. This process is included in the system described in: Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007 Other processes in the CPM Database also included in the above publication: - Bore-hole based air-conditioning system. ESA-DBP - Air-conditioning system. ESA-DBP - Air-and-water air conditioning system. ESA-DBP - All-air air handling unit with a cooling coil and vapour compression chiller with a refrigerant. ESA-DBP - All-air desiccant cooling air handling unit. ESA-DBP - Operation on desiccant cooling system - a technology in air conditioning. ESA-DBP

System Boundaries	
Nature Boundary	The inventory analysis included parameters describing resource use and emissions to air and water from the energy production.
Time Boundary	1995-2000
Geographical Boundary	Sweden
Other Boundaries	Main assumptions made for this study are: constant airflow, total airflow 5m3/s, supply air temperature - 17°C, exhaust air temperature - 24°C, operating time - 8760 [hours/year], SFP 2.4 [kW/(m3/s)]. Excerpt from the report, see 'Publication': ''The vapour compression air-cooling process is modelled to be performed by a cooling coil with a constant surface temperature of 100'C. Graphically on a psychometric chart, in case of a wet (sensible or latent) cooling process, this means that the ambient air condition will change in the direction towards the air condition 10'C/100% RH. The evaporating temperature of the refrigerant is 15K lower than the coil surface temperature (-5°C). The condensing temperature is 15K higher than the actual ambient air temperature. Finally, the electricity use by the compressor for cooling the air is calculated hour by hour with a total Carnot efficiency of 0.5. In heating mode, a heat exchanger with the same temperature efficiency as in case of the desiccant cooling system is presumed. Consequently, the vapour compression system requires heat energy when ambient air temperature is below 0°C. The refrigerant is HFC-134a and the charge of the system is 23.5 kg. The annual leakage is assumed 2% of the charge.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''(...) Environmental performance is studied by a simplified LCA; therefore, also the quantification of materials can be simplified. (...) The amounts of materials in air handling units and cooling machines were estimated from previously published information or collected from producers of the particular equipment. (...) The cooling loads and annual operating energy were estimated by calculations using the software for heat balance of buildings BV2.''
Literature Reference	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/Heikkila_et_al_2007
Notes	NB: Please note that the data relate only to the annual operating energy use during the user phase.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Resource	Aluminium ore	4.30E+00			kg	Ground	Sweden
	Input	Resource	Coal in ground	1.64E+04			kg	Ground	Sweden
	Input	Resource	Copper ore	5.00E-03			kg	Ground	Sweden
	Input	Resource	Oil in the ground	8.12E+02			kg	Ground	Sweden
	Output	Emission	BOD	5.00E-03			kg	Water	Sweden
	Output	Emission	CH4	2.50E+00			kg	Air	Sweden
	Output	Emission	CO	2.00E-01			kg	Air	Sweden
	Output	Emission	CO2	4.50E+04			kg	Air	Sweden
	Output	Emission	COD	1.00E-01			kg	Water	Sweden
Notes: non elementary output	Output	Emission	Dust	3.00E-02			kg	Other	Sweden
	Output	Emission	NMVOC	6.00E-02			kg	Air	Sweden
	Output	Emission	NOx	1.12E+02			kg	Air	Sweden
	Output	Emission	N-tot	7.00E-04			kg	Water	Sweden
	Output	Emission	SOx	2.81E+02			kg	Air	Sweden

About Inventory

Publication	Heikkilä K. (2007). Environmental Assessment of Air-conditioning Systems. Design Considerations for Swedish Conditions. Report no. D 2007:2, Department of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/Heikkila_et_al_2007
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''An objective of this work was that it should lead to an increased knowledge of how to work with environmental issues related to air-conditioning systems for office buildings and to a greater awareness of the environmental loads related to these systems. (...) The objectives of this thesis are to: - describe how the environmental performance of air-conditioning systems can be assessed and evaluated at the design stage. The focus is on the application of existing methods for environmental assessment of these systems. - identify and discuss the major sources of the environmental impacts and give some general recommendations as to how to design air-conditioning systems to improve their environmental performance. - outline possible key performance indicators (KPI) for the environmental performance of the most common types of air-conditioning systems.''
Detailed Purpose	Vapour compression cooling is a one of the air conditioning technologies, therefore it was an object of the study.
Commissioner	Unknown - .
Practitioner	Katarina Heikkilä - .
Reviewer	Jan-Olof Dalenbäck, Torbjörn Lindholm, - Building Services Engineering, Energy and Environment, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	For more information and the comparison with the other systems see the report. The reference report is a thesis for the degree of doctor. As a part of it, five papers are included. Paper I relates to the comparison of operational energy in use phase between vapour compression cooling and desiccant cooling systems. The function and other information was taken from the mentioned Paper I. Inventory data come from the main part of the report.

SPINE LCI dataset: Ore-based steel production

Administrative	
Finished	Y
Date Completed	1996-10-01
Copyright	
Availability	Public

Technical System	
Name	Ore-based steel production
Functional Unit	kg
Functional Unit Explanation	1 kg ore-based steel
Process Type	Cradle to gate

Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	The ore-based steel production includes Olivine and bentonite mining Iron-core mining, dressing, concentrating and pelletizing Lime production Coal mining Scrap refining Steel production (from pellets to slabs) Coking plant (with coal storage) Blast furnaces Steel plant (with lime kiln and continuous casting) Oxygen plant Rolling mill Olivine and bentonite mining Olivine is transported by truck or lorry about 50 km from Purnu (Iso Sormus) were it is mined, to LKAB Malmberget. Bentonite is imported from Greece and transported by boat 8500 km to Luleå and then by railway 260 km to Malmberget. Iron-core mining, dressing, concentrating and pelletizing Fines and pellets are produced, based on iron-ore. After mining, the granite is removed in the sorting plant by crushing, sifting and magnetic separation. The dressed iron-ore is then taken to the benefication plant, where about half of the quantity is wet-sifted and separated into sinterfines and sold as such. Remaining products from the dressing plant are used for pellets production in the pelletizing plant, in which the following activities occur: further concentration, adding of olivine, dewatering, rolling into pellets and finally a burning process. The pellets are transported by railway 260 km from LKAB Malmberget to Svartön in Luleå. Lime production Lime is taken from Gotland and transported by ship 1000 km to Luleå. Coal mining Coal is taken from USA (50%) and Australia (50%) directly to Luleå by large ships. The average distance is 500 km by train and 15 000 km by boat. Scrap refining Scrap is transported 40 km by lorry from earlier user to scrap refining plant. Swedish scrap is transported by train or by lorry, and the imported scrap is transported by boat. When assuming that 50% of the scrap comes from Sweden, 25% from Germany and remaining 25% from Poland, the weighed average transporting distance is 150 km by train, 50 km by lorry and 700 km by boat. Steel production (from pellets to slabs) The production process is divided into the following main steps: Coking plant (with coal storage) At the coking plant, coke is produced from coal for use in the blast furnaces. The coking process acts as a dry distillation without oxygen supply, where all volatile compounds are evaporated and a gas is obtained as a result. This gas is then further refined in several steps into coke gas. Sulphur, tar, benzene etc. are obtained as by-products and are sold. The coke is transported by assembly lines to the blast furnaces or to storing. The coke gas is used as a fuel in the coke battery and in the steamboilers. The excess gas is used in the blast furnaces or distributed to a power and heating plant. Bio sludge occurs as a low-grade product, as it is reused in the process. Blast furnaces In the blast furnaces, liquid raw iron (pig iron) is produced from pellets with reducing agents (coke and coal powder) slag formers (mainly lime) and some other additives. As raw materials are supplied from above in the furnaces, oxygen is added from beneath. The oxygen reacts with the coal and the gas is separated. The liquid iron sinks through the coal. The iron is tapped at intervals at the bottom of the furnace while the slag, floating at the surface, is tapped continuously from the surface. The iron is then transported in torpedos to the steel plant. Steel plant (with lime kiln and continuous casting) The raw, liquid iron is transported to the steel plant. In the desulphurizing process calcium carbide, magnesium and soda are added to the iron, reacting with the sulphur in the iron and producing slag that is removed. In the LD-converter the desulphurized raw iron is transformed into steel. The carbon content is decreased into less than 0.5% by blowing oxygen gas at the surface of the liquid iron, which makes the carbon oxidize and evaporate as gas. Steel scrap is added, both to cool and to serve as a raw material. Liquid steel and slag is tapped separately from each other. Argon is added from beneath to homogenize the steel. Small quantities of aluminum are added to remove any remaining oxygen. The liquid steel is then continuously cast into slabs. The slag is crushed and sieved into two fractions, one that is deposited and one that is reused in the blast furnaces. Excavation masses and industrial waste is landfilled or used as filling materials, both alternatives locally. Oxygen plant

	There is also a smaller cold-rolling mill that has not been taken into account in this study, since studied steel products do not pass this rolling mill. The steel slabs are transported from Luleå to Borlänge 863 km by train. Rolling mill All slabs are hot-rolled into coils. Around 50% of the coils are then further processed in the cold-rolling mill and 25% is then galvanized with a layer of zinc or an alloy of aluminum and zinc. Finally, some products get a coating of paint. Final products have a thickness of maximum 16 mm with a maximum breadth of 1600 mm. Main chemicals that are used are ammonia, oils, rolling liquids and chemicals for water treatment. Oil emissions to air as aerosols arise from the cold-rolling mill.

System Boundaries

Nature Boundary	The analysis comprises among other activities limestone quarrying, olivine-, bentonite-, coal and iron-ore mining, which implies that these raw materials are taken direct from the nature. Steel production Coking plant Parameters that have been measured but are below the detection level have been excluded; to air dioxines, to water oil, phenol, suspended solids, CN-tot, As, Cd, Mn and Zn. No waste of importance occurs. Steel plant Emissions to air and water Parameters that have been measured but are below the detection level have been excluded. All metal emissions to air accounted for are bound to particles, except Hg. Emissions to water arise from the blast furnaces, the continuous casting process and the rolling mill (emissions from the coking plant are accounted for). Rolling mill Emissions to air and water Hydrocarbon emissions to air have been omitted, as they arise from the coating process. Emissions to water are allocated to cold-rolled products.
Time Boundary	
Geographical Boundary	Sweden, except for bentonite which is imported from Greece, coal which is mined in USA and Australia and steel scrap which comes from Germany (25%) and from Poland (25%).
Other Boundaries	Steel production As coal is in this process used as a raw material, it is here accounted for as raw material, whereas the feedstock energy is accounted for at the coal extraction step. Blast furnaces Raw materials Manganese ore or manganese slag is used as an alloy material. Steel plant In lime is included all burnt lime and dolomite lime. Among the alloy materials, ferrous manganese, ferrosilicon manganese, aluminum and ferrosilicon are the ones mostly used. Additives mainly refers to calcium carbide. The most important chemicals are lubricating oils, anticorrosive agents and acids. Energy use Data for heating of buildings and internal transports for all connected activities is included. In industrial waste is also included construction and demolition waste, excluding excavation masses. Municipal waste is not considered. Hazardous waste mainly consists of residue oil and other waste with an oil content. Rolling mill Hazardous waste mainly consists of residue oil, oil-contaminated glow-scale sludge and sludge with a chromium and zinc content.
Allocations	Iron-core mining, dressing, concentrating and pelletizing: Raw material The raw ore used for the production process is equally allocated per weight on total production of fines and pellets, and so is olivine. Bentonite is allocated to production of pellets. Of the explosives (allocated to fines and pellets production by weight), 97% consist of Kimulux. About half the amount of chemicals used is hydraulic oil, and the rest is mainly defatteners, oils and lubricants. Accounted volumes of granite refer to dry weight. Chemicals are allocated to production of pellets. Explosives and chemicals are regarded in the calculations as non-elementary flows. Emissions to air and water Emissions to air are allocated to pellets production, since the main impact occurs at the pelletizing plant. CO2 emissions have been calculated based on use of fossil fuel. Most SO2 emissions (about 85%) arise from the sulphur content in the mineral, and combustion of fossil fuels is responsible for the rest. Emissions to water have been equally distributed per weight on production of both sinterfines and pellets. Emissions to water come from the sedimentation dams. Emissions to water are three times higher than measured average

	values as suggested in the environmental report, based on estimations of the annual overflow from the sedimentation dams. Waste Dry mineral waste (granite etc.) from mining and dressing is deposited within the production area or is used as a filling material for restauration of old open pit mines nearby. Mineral waste occurring from the concentration process follows as slurry with the flushing water from the process and is then stored in connection to a sedimentation dam. One third of the industrial waste is fines and pellets waste from internal research and development work. The industrial waste is transported by truck to a landfill about 2,5 km away. The hazardous waste consists of lubricants and residual oils. Granite waste is allocated to production of fines and pellets, and other waste is allocated to pellets production. Steel production Coking plant Like the coke, the products sulphur, tar, benzene, coke dust and coke gas all have an economic value. According to calculations made by Sunér M (Life Cycle Assessment of Aluminium, copper and steel. Report 1996:6, Technical Environmental Planning, Chalmers University of Technology, Göteborg, 1996) the value of produced coke stood in 1992 for 85,3% of the total economic value of the outflows of the coking plant. In table 6.5 allocation of the environmental load of the coking plant is based on this premise. Also, according to Sunér, 66% of the coke gas is used internally; 49% in the coke plant and 17% in the blast furnace. Blast furnace The total environmental impact is allocated to the iron. Steel plant Product The environmental load is distributed on total liquid steel production, including some raw steel which is sold before the casting process. Rolling mill Data refers to cold-rolled galvanized coils. For most parameters the environmental load is given aggregated for all process steps, and the load is then allocated to the production at the process step most responsible. The environmental loads that are specifically connected with the coating process are omitted in the calculations. Products Main products, to which the environmental impact is allocated, are hot-rolled coils, cold-rolled coils, galvanized and coated coils. Glow scale and ferrous oxide, scrap, zinc slag and aluminum slag are all defined as low-grade products, as they all have a market and are recycled or further used in other ways. No environmental impact is allocated to these low-grade products. Energy Use of electricity, fuel oil and liquefied petroleum gas (LP gas) is allocated between the process steps according to amount used in each process step. Use of petrol and diesel is equally distributed per weight on all products, independently of refining level. Emissions to air and water Emissions of NOx and particulates are based on measurements, and have been allocated equally per weight to all sold products. Waste Waste is allocated equally per weight on total production of coils.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Inventory
Literature Reference	Olive mining, Pellet production: Ögren P. Miljörapport 1994, LKAB:s verksamhet i Malmberget. LKAB (Luossavaara Kiirunavaara AB), Kiruna, 1995 Lime production: Edholm A., Cementa AB, Stockholm, 1993
Notes	The data has been collected during 1996 but the sources is probably a year or a few years older. An inventory is made including the following companies and processes: LKAB, Iso Sormus: Olivine and bentonite mining; Iron-core mining, dressing, concentrating and pelletizing SSAB, Luleå: Steel production Stena Metall: Scrap refining SSAB, Borlänge: Rolling mill The data type unspecified implies that one do not know what the data is based on.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***

Notes: Additives mainly refer to calcium carbide. The most important chemicals are lubricating oils, anticorrosive agents and acids.	Input	Refined resource	Additives	5.04			g	Other	
Notes: Among the alloy materials, ferrous manganese, ferrosilicon manganese, aluminum and ferrosilicon are the ones mostly used.	Input	Refined resource	Alloy materials	50.5			g	Other	
	Input	Refined resource	Chemicals	4.99			g	Other	
Notes: Feedstock energy 14.1	Input	Refined resource	Coal	0.223			MJ	Other	
Notes: As coal is in this process used as a raw material, it is here accounted for as raw material, whereas the feedstock energy is accounted for at the coal extraction step.	Input	Refined resource	Coal	517			g	Other	
	Input	Refined resource	Diesel	0.195			MJ	Other	
	Input	Refined resource	Electricity	3.29			MJ	Other	
	Input	Refined resource	Explosives	1.02			g	Other	
	Input	Refined resource	Gas	4.81			MJ	Other	
Notes: Heavy fuel	Input	Refined resource	Heavy oil	2.88			MJ	Other	
	Input	Refined resource	Iron ore	2170			g	Other	
Notes: In lime is included all burnt lime and dolomite lime.	Input	Refined resource	Limestone	162			g	Other	
Notes: Light fuel (Eo1)	Input	Refined resource	Oil (eo1)	0.00106			MJ	Other	
	Input	Refined resource	Scrap	52.2			g	Other	
	Output	Emission	Al	0.000517			g	Water	
	Output	Emission	As	0.00000208			g	Water	
	Output	Emission	Ashes	0.0117			g	Air	
	Output	Emission	Cd	0.0000000446			g	Water	
	Output	Emission	Cd	0.0000118			g	Air	
	Output	Emission	CH_4	4.04			g	Air	
	Output	Emission	Cl	0.181			g	Water	
	Output	Emission	Co	0.00000321			g	Water	
	Output	Emission	Co	0.0000072			g	Air	
	Output	Emission	CO	0.0547			g	Air	
	Output	Emission	CO_2	1180			g	Air	
	Output	Emission	COD	0.0256			g	Water	
	Output	Emission	Cr	0.0000488			g	Water	
	Output	Emission	Cr	0.00036			g	Air	
	Output	Emission	Cu	0.000101			g	Water	
	Output	Emission	Cu	0.000175			g	Air	
	Output	Emission	Dissolved solids	0.517			g	Water	
	Output	Emission	F	0.00000155			g	Water	
	Output	Emission	Fe	0.00717			g	Water	
	Output	Emission	HC	0.0626			g	Air	
	Output	Emission	HCl	0.0418			g	Air	
	Output	Emission	HF	0.0562			g	Air	
	Output	Emission	Hg	0.0000344			g	Air	
Notes: As	Output	Emission	Metals (toxic)	0.0000187			g	Air	
	Output	Emission	Mn	0.0000245			g	Air	
	Output	Emission	Mn	0.00309			g	Water	
	Output	Emission	NH_3	0.000517			g	Water	
	Output	Emission	Ni	0.0000815			g	Water	
	Output	Emission	Ni	0.0004			g	Air	
	Output	Emission	NO_x	1.49			g	Air	
	Output	Emission	N-tot	0.0318			g	Water	
	Output	Emission	Oil (aq)	0.0000439			g	Water	

	Output	Emission	Oil(air)	0.007			g	Air	
	Output	Emission	PAH	0.000147			g	Air	
	Output	Emission	Particles	1.5			g	Air	
	Output	Emission	Pb	0.000402			g	Water	
	Output	Emission	Pb	0.000529			g	Air	
	Output	Emission	Phenol	0.000000625			g	Water	
	Output	Emission	P-tot	0.000372			g	Water	
	Output	Emission	SO4--(aq)	0.259			g	Water	
	Output	Emission	SOx	1.52			g	Air	
	Output	Emission	Sr	0.00517			g	Water	
	Output	Emission	Susp solids	0.0433			g	Water	
	Output	Emission	Zn	0.000997			g	Water	
	Output	Emission	Zn	0.00368			g	Air	
	Output	Product	Steel	1			kg	Technosphere	
Notes: Hazardous waste mainly consists of residue oil and other waste with oil content.	Output	Residue	Hazardous waste	1.62			g	Other	
Notes: In industrial waste is also included construction and demolition waste, excluding excavation masses. Municipal waste is not considered.	Output	Residue	Industrial waste	96.4			g	Other	
	Output	Residue	Mineral waste	1100			g	Other	

About Inventory

Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural concrete and steel frames in buildings during the whole life-cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of steel
Commissioner	- Finncement and Trätek (The Swedish Institute for Wood Technology Research) Box 5609 S-114 86 Stockholm Sweden.
Practitioner	Björklund T., Jönsson Å., Tillman A-M - Technical Environmental Planning, CTH Sven Hultins Gata 8 412 96 Göteborg Sweden .
Reviewer	
Applicability	
About Data	Coal mining Half the amount of coal is imported from Australia and half from USA. The data used are average values for mineral coal used in Europe based on 50% open-pit mining and 50% underground mining. Steel production Blast furnaces Raw materials It is assumed in the calculations that all slag formers consist of lime. It is also assumed that coal used in the blast furnaces is the same as the coal used in the coking plant. Alloy materials are treated as non-elementary flows. Energy use Gases are taken from the coking plant and the blast furnaces. Use of blast furnace gas is not included in the calculations, as this energy originates from use of coke which is already accounted for as material use. Steel plant Products Material flows reused directly in the process are not accounted for. The low-grade products scrap and glow scale have an economic value, though minor compared to the main product, and they are therefore excluded in the calculations. No environmental load is allocated to these products. This is also the case for production of excavated masses (including the load from coking plant and blast furnaces). Raw materials Some chemicals that have originally been accounted for in volume have been recalculated

	into weight, assuming an average density of 1000 kg/m3. Alloy materials, additives and chemicals are regarded as non-elementary flows. Waste Since it is assumed that excavation masses have no further environmental consequences and may serve a useful purpose they are regarded as low-grade products, and no environmental load is allocated to them. Some categories of hazardous waste have been recalculated from volume to mass, assuming a density of 900 kg/m3. Rolling mill For the chosen process, about 70% of the slabs come from SSAB in Luleå, and remaining 30% is produced at SSAB in Oxelösund. It is assumed in the calculations that all slabs are produced in Luleå. Raw materials Alloy materials consist to about 80% of zinc, and the rest is aluminum. Although these products are refined in the Nordic countries, the ore is extracted in more distant countries. The environmental impact of extraction and refining of alloy materials are treated as non-elementary flows. Also acids and chemicals are regarded as non-elementary flows. Some liquid chemicals (like defatteners and anticorrosive agents) have been recalculated from volume into weight, and it is then assumed that one liter corresponds to one kg. Energy A minor quantity of energy is taken from the municipal district heating system, but since this amount is insignificant it has been neglected. Emissions to air and water CO2 emissions have been calculated based on consumption of fossil fuels (allocation based on fuel use in each process step). SO2 emissions are calculated based on sulphur content in fuel oil. Waste Some waste categories have been recalculated from volume to weight. A density of 850 kg/m3 has then been assumed for residue oil, oil sludge, fats and solvents and 1700 kg/m3 for glow-scale sludge. Internally recovered waste products have been omitted in the calculations (like used bate acids).
Notes	

SPINE LCI dataset: Particleboard production

Administrative	
Finished	Y
Date Completed	1997-05-01
Copyright	
Availability	Public

Technical System	
Name	Particleboard production
Functional Unit	kg
Functional Unit Explanation	1 kg particleboard
Process Type	Cradle to gate
Site	Norway
Sector	Materials and components
Owner	Norway
Technical system description	A particleboard is formed on a press table under heat and pressure.

System Boundaries	
Nature Boundary	Waste of glue, wood and particleboard pieces is decomposed in the nature.
Time Boundary	
Geographical Boundary	Norway

Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Study literature data. Data in Fossdal has been modified by Martin Erlandson at Trätek, based on discussions with Sverre Fossdal.
Literature Reference	Fossdal S, Energi og miljÆegenskaper for bygg, Fremstellning av byggematerialer. Regenskaper for boliger og kontorbygg, Prosjektrapport 173, Norges Byggforskningsinstitutt, Oslo, 1995
Notes	The data is incomplete, there is missing data for raw materials and emissions to water.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Diesel	0.38			MJ	Other	
	Input	Refined resource	Electricity	1.51			MJ	Other	
	Input	Refined resource	Oil	1.03			MJ	Other	
	Input	Refined resource	Renewable fuel	5.02			MJ	Other	
	Output	Emission	CO	5.7			g	Air	
	Output	Emission	CO2	99			g	Air	
	Output	Emission	NH3	0.1			g	Air	
	Output	Emission	NOx	3.6			g	Air	
	Output	Emission	Particles	1.36			g	Air	
	Output	Emission	SO2	0.26			g	Air	
	Output	Emission	VOC	0.8			g	Air	
Notes: It is assumed that the density of the particleboard is 650 kg/m3 (dry substance).	Output	Product	Particleboard	1			kg	Technosphere	
	Output	Residue	Ashes	1.26			g	Other	
Notes: Industrial waste consists of cured glue.	Output	Residue	Industrial waste	0.01			g	Other	

About Inventory

Publication	LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund, Tillman; Report 1997:2; TEP; CTH; Göteborg; Sweden --- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology ---
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural wooden and concrete frames in buildings during the whole life-cycle, by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of wooden frames
Commissioner	- Finncement Finland .
Practitioner	Björklund Thomas, Tillman Anne-Marie - Technical Environmental Planning, CTH 412 96 Göteborg Sweden.
Reviewer	

Applicability	The function of the technical system is not sufficently described. Contact Norges Byggforskningsinstitutt in Oslo (Fossdal S, Energi og miljÆegenskaper for bygg, Fremstellning av byggematerialer. Regenskaper for boliger og kontorbygg, Prosjektrapport 173) to get the necessary details.
About Data	The raw materials consist of scrap wood (80-90%) with the addition of glue (10-20%, Urea-formaldehyde).
Notes	

SPINE LCI dataset: Passenger plane, MD-82

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Passenger plane, MD-82
Functional Unit	1 tonkm, 300 km, 49 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for a flight distance of 300 km and a utilisation level of 49 % passenger occupation (6 450 kg).
Process Type	Unit operation
Site	Sweden
Sector	Air transport
Owner	Sweden
Technical system description	Operation of MD-82 aircraft carrying both passengers and cargo. The operation includes take-off, climb, cruise, descent and landing (including operations on the ground) *Technical data for the aircraft:* Maximum take-off weight: 67,8 tonnes. Maximum payload (i.e. maximum loading capacity with regard to weight): 17100 tonnes. Maximum loading capacity for the cargo: 3 tonnes Max cruising altitude 11,300 metres Cruising speed 815-825 km/h Length: 45.1 m Wing span: 32.9 m Range: 3,200 km Engine: P&W JT8D-217C/-219

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents aircraft in use in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The data is only valid for a flight distance of 300 km, and an average utilisation equivalent to 49 % (6 450 kg) passenger occupation. *Parameters not considered*

	-External conditions i.e. climate etc -Maintenance level of the aircraft. *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel -Maintenance of the aircraft -After-treatment of the aircraft -Handling of production rests
Allocations	The energy use and emissions only refer to the additional fuel consumption and emissions that occur as a result of the extra weight of the goods. The remaining energy use and emissions have been allocated to the passengers. This is a marginal argument based on the fact that only small amounts of goods are carried in passenger aircraft. The passenger occupation will thus have a large influence on the total energy use and emissions.
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Modeled data
Represents	See 'Function'
Method	The energy use and emissions only refer to the additional fuel consumption and emissions that occur as a result of the extra weight of the goods. The quantity value corresponds to a passenger occupation of 49% (6450 kg) and a flight distance of 300 km. The energy use and emissions was obtained by simulation calculations performed by FFA (The Aeronautical Research Institute of Sweden). The simulation calculations is performed in two steps. To obtain the fuel consumption, the flight path for each section is simulated, where both load and flight distance is accounted for. The position of the aircraft and the operation conditions of the engine are established for every second of the flight. This data is used in a new simulation where the exhaust emissions are calculated with regard to engine speed and flying altitude for every moment of the flight. The result from the simulation is then used to calculate the energy use and emissions per tonkm. The data include landing and take off, i.e. flight operations below 3000 feet (including operation of the ground), *Data used for the fuel:* -Thermal value: 43,2 MJ/kg -Sulphur content 500 ppm
Literature Reference	Larsson, Lars Gunnar, Calculations performed at FFA for NGM, 1997, Not published
Notes	The data is only valid for a flight distance of 300 km and was used as the maximum value for passenger planes in NGM The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Kerosene	2.1			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	0.03			g	Air	
	Output	Emission	CO2	150			g	Air	
	Output	Emission	HC	0.0042			g	Air	
	Output	Emission	NOx	2.2			g	Air	
	Output	Emission	SO2	0.048			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 --- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions

	associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Larson, Lars-Gunnar - FFA (Flygtekniska försöksanstalten), Box 11021 S-161 11 Bromma Sweden.
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the plane, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Goods transportation by air transport is done either in special freight planes or in regular passenger flights together with passengers. Air transport is primarily used for transportation of valuable or fragile goods and for speedy deliveries. Air transport is also more expensive than other modes of transportation. Consequently, very little goods are transported by aircraft. The major part of the goods is transported in regular passenger planes. The amount of goods that can be carried in passenger aircraft is however small. The average load of goods in a passenger aircraft is below 100 kg and is equivalent to an average passenger with average luggage. The passenger occupation will therefore have a large influence on the energy use and the emissions for goods carried in regular passenger aircraft. The MD-82 was chosen to represent Swedish air transport since it is one of the most common used aircraft in domestic regular traffic in Sweden. The aircraft represents an average regarding both technical standard and emissions. The aircraft has a long average lifetime. ***Utilisation level and distance*** For air transports, data on energy use and emissions per tonkm may only be given for a specific flight distance since the energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights longer than 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance. Consequently, the longer the flight the more energy efficient transport. Aircraft are optimised for energy efficiency during the cruise phase. The average distance for Swedish domestic flights is between 300 and 600 km. Data for passenger planes was therefore only given for a short flight distance (300 km) and a low average utilisation level (49 %) and a long flight distance (600 km) and a high average utilisation level (81%). The reason for this was to give an indication of a maximum and a minimum value of the energy use and emissions for goods carried in passenger planes in Swedish domestic traffic. To calculate energy use and emissions for other flight distances, the following relations may be used, where x=total distance in km. These relations are valid for flights longer than 300 km and concern a MD-82 loaded with 9450 kg i.e. a utilisation level equivalent to a passenger occupation of 65%. -Kerosene: 2220 + 3,1*(x-300) [kg] -CO_2: 7015 + 9,8*(x-300) [kg] -CO: 9,6 + 0,0129*(x-300) [kg] -HC: 1,848 + 0,0049*(x-300) [kg] -NO_x: 29,85 + 0,031*(x-300) [kg] -SO_2: 2,22 + 0,003*(x-300) [kg]
About Data	The data was used as a maximum value for passenger planes in the work of NGM.The data is based on simulation calculations performed at FFA (The Aeronautical Research Institute of Sweden).

Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Passenger plane, MD-82

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Passenger plane, MD-82
Functional Unit	1 tonkm, 600 km, 81%
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for a flight distance of 600 km and an utilisation level equivalent to 81 % passenger occupation (12 450 kg).
Process Type	Unit operation
Site	Sweden
Sector	Air transport
Owner	Sweden
Technical system description	Operation of MD-82 aircraft carrying both passengers and cargo. The operation includes take-off, climb, cruise, descent and landing (including operations on the ground) *Technical data for the aircraft:* Maximum take-off weight: 67,8 tonnes. Maximum payload (i.e. maximum loading capacity with regard to weight): 17100 tonnes. Maximum loading capacity for the cargo: 3 tonnes Max cruising altitude 11,300 metres Cruising speed 815-825 km/h Length: 45.1 m Wing span: 32.9 m Range: 3,200 km Engine: P&W JT8D-217C/-219

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO_2 -tax regulated CO_2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other

	environmental loads have not been considered.
Time Boundary	The data represents aircraft in use in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The data is only valid for a flight distance of 600 km, and an average utilisation equivalent to 81 % passenger occupation (12 450 kg). *Parameters not considered* -External conditions i.e. climate etc -Maintenance level of the aircraft. *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel -Maintenance of the aircraft -After-treatment of the aircraft -Handling of production rests
Allocations	The energy use and emissions only refer to the additional fuel consumption and emissions that occur as a result of the extra weight of the goods. This is a marginal argument. The remaining energy use and emissions have been allocated to the passengers, i.e the passengers and the plane. Since only small amounts of goods are carried in passenger aircraft, the passenger occupation will have a large influence on the total energy use and emissions.
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Modeled data
Represents	See 'Function'
Method	The energy use and emissions only refer to the additional fuel consumption and emissions that occur as a result of the extra weight of the goods. The quantity value corresponds to a passenger occupation of 81 % (12450 kg) and a flight distance of 600 km. The energy use and emissions was obtained by simulation calculations performed by FFA (The Aeronautical Research Institute of Sweden). The simulation calculations is performed in two steps. To obtain the fuel consumption, the flight path for each section is simulated, where both load and flight distance is accounted for. The position of the aircraft and the operation conditions of the engine are established for every second of the flight. This data is used in a new simulation where the exhaust emissions are calculated with regard to engine speed and flying altitude for every moment of the flight. The result from the simulation is then used to calculate the energy use and emissions per tonkm. The data include landing and take off, i.e. flight operations below 3000 feet (including operation of the ground), *Data used for the fuel:* -Thermal value: 43,2 MJ/kg -Sulphur content 500 ppm
Literature Reference	Larsson, Lars Gunnar, Calculations performed at FFA for NGM, 1997, Not published
Notes	The data is only valid for a flight distance of 600 km and was used as a minimum value for passenger planes in NGM. The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Kerosene	1.8			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	0.023			g	Air	
	Output	Emission	CO2	140			g	Air	
	Output	Emission	HC	0.0038			g	Air	
	Output	Emission	NOx	1.5			g	Air	
	Output	Emission	SO2	0.042			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Larson, Lars-Gunnar - FFA (Flygtekniska försöksanstalten), Box 11021 S-161 11 Bromma Sweden.
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the plane, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Goods transportation by air transport is done either in special freight planes or in regular passenger flights together with passengers. Air transport is primarily used for transportation of valuable or fragile goods and for speedy deliveries. Air transport is also more expensive than other modes of transportation. Consequently, very little goods are transported by aircraft. The major part of the goods is transported in regular passenger planes. The amount of goods that can be carried in passenger aircraft is however small. The average load of goods in a passenger aircraft is below 100 kg and is equivalent to an average passenger with average luggage. The passenger occupation will therefore have a large influence on the energy use and the emissions for goods carried in regular passenger aircraft. The MD-82 was chosen to represent Swedish air transport since it is one of the most common used aircraft in domestic regular traffic in Sweden. The aircraft represents an average regarding both technical standard and emissions. The aircraft has a long average lifetime. ***Utilisation level and distance*** For air transports, data on energy use and emissions per tonkm may only be given for a specific flight distance since the energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights longer than 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance. Consequently, the longer the flight the more energy efficient transport. Aircraft are optimised for energy efficiency during the cruise phase. The average distance for Swedish domestic flights is between 300 and 600 km. Data for passenger planes was therefore only given for a short flight distance (300 km) and a low average utilisation level (49 %) and a long flight distance (600 km) and a high average utilisation level (81%). The reason for this was to give an indication of a maximum and a minimum value of the energy use and emissions for goods carried in passenger planes in Swedish domestic traffic. To calculate energy use and emissions for other flight distances, the following relations may

	be used, where x=total distance in km. These relations are valid for flights longer than 300 km and concern a MD-82 loaded with 9450 kg i.e. a utilisation level equivalent to a passenger occupation of 65%. -Kerosene: 2220 + 3,1*(x-300) [kg] -CO2: 7015 + 9,8*(x-300) [kg] -CO: 9,6 + 0,0129*(x-300) [kg] -HC: 1,848 + 0,0049*(x-300) [kg] -NOx: 29,85 + 0,031*(x-300) [kg] -SO2: 2,22 + 0,003*(x-300) [kg]
About Data	The data was used as a minimum value in the work of NGM. The data is based on simulation calculations performed at FFA (The Aeronautical Research Institute of Sweden).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Pea cultivation. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Pea cultivation. ESA-DBP
Functional Unit	1 kg of pea
Functional Unit Explanation	1 kg of pea on the yield with capacity 3400kg/ha
Process Type	Gate to gate
Site	Unknown
Sector	Crop and animal production, hunting etc.
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''Peas require a relatively cool and humid climate, preferably in the temperature range of 7-30°C. They are cultivated in most parts of the world, being one of the most important legumes among soybean, groundnut, and beans. It is considered to be a suitable rotational crop, as it is self-providing with nitrogen and thus does not require additional fertilisers, except when nodulation is poor of fails completely. Crop rotation helps creating diversity in the agricultural system, and to use resources in an efficient way. (...) In this study we assume that the extra wheat generated replaces cultivation of winter wheat in a cereal crop rotation. Apart from increasing the yield, peas can also reduce the need for pesticides in the subsequent crop. (...) Harvested peas usually have a water content of about 20%, hence the crop has to be dried in order to reach the desired value for storage and processing of about 14-15%, this in order to maximise durability.

	Data on pea and wheat cultivation was taken from, based on a pea yield of 3 400 kg/ha.'' This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Pea-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Production of beef. ESA-DBP - Production of pork. ESA-DBP - Rape seed cultivation. ESA-DBP - Wheat cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean processing. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries

Nature Boundary	Data include use of energy, as well as emissions to air and water.
Time Boundary	For the study data from the year 2005 were used.
Geographical Boundary	The study was done for Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': ''Not included are any aspects regarding personnel. (...) For these reasons, pesticides, fungicides and herbicides are only taken into account quantitatively in the inventory section in this study (when data have been available), but are not analysed further in the results section. (...) some ingredients in the food processes have been judged to contribute very little to the overall process, and have therefore been excluded.
Allocations	No information about the allocation in the report.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2005
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other report.
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf The particular data come from: Cederberg, C. & Flysjö, A. (2004). Environmental Assessment of Future Pig Farming Systems - Quantification of Three Scenarios from the FOOD 21 Synthesis Work. SIK report no.723. Swedish Institute of Food and Biotechnology (SIK), Gothenburg, Sweden
Notes	The data is only valid for a flight distance of 600 km and was used as a minimum value for passenger planes in NGM. The energy use and emissions vary substantially during the different phases of the flight. A flight may be considered to consist of 5 phases - take-off, climb, cruise, descent and landing (including operations on the ground). The take-off and climb are the most energy demanding phases and give rise to extensive emissions. For flights over 300 km, the energy use and emissions at take-off, climb, descent and landing may be considered to be constant, independent of the flight distance.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Input Product	Herbicides	5.60E-02			g	Technosphere	Sweden
	Input	Input Product	Insecticides	4.40E-02			g	Technosphere	Sweden
	Input	Natural resource	Water	9.00E-02			l	Water	Sweden
	Input	Refined resource	Diesel	8.80E-01			MJ	Technosphere	Sweden
Notes: For milling	Input	Refined resource	Electricity	1.51E+00			MJ	Technosphere	Sweden
Notes: For drying	Input	Refined resource	Electricity	3.60E-01			MJ	Technosphere	Sweden

Notes: For drying	Input	Refined resource	Heat oil	2.00E-01			MJ	Technosphere	Sweden
Notes: For milling	Output	Emission	Heat oil	3.00E-02			MJ	Technosphere	Sweden
	Output	Emission	N2O	4.70E-04			g	Air	Sweden
	Output	Emission	Nitrate	7.10E-03			g	Air	Sweden
	Output	Product	Pea	1.00E+03			g	Other	Sweden

About Inventory	
Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .
Practitioner	Anders Abelmann - Chalmers University of Technology.
Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The data for pea cultivation were taken from: Cederberg, C. & Flysjö, A. (2004). Environmental Assessment of Future Pig Farming Systems - Quantification of Three Scenarios from the FOOD 21 Synthesis Work. SIK report no.723. Swedish Institute of Food and Biotechnology (SIK), Gothenburg, Sweden

SPINE LCI dataset: Peat fired plant for heat and power production

Administrative	
Finished	Y
Date Completed	2000-07-07
Copyright	
Availability	Public

Technical System	
Name	Peat fired plant for heat and power production

Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a peat fired plant for heat and power production. The plant is located in Sweden and can be fired with oil, wood chips, pulverized peat and/or coal. Heat is produced and delivered to a district heating net. In this study the emissions from the incineration of peat is reported. Production of materials, chemicals, electricity and transport, used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: The technical data presents the total production from the plant. The yearly production from different fuels could not be seperated. Average annual time of use (hours): 4300 (of which 3557 hours with peat) Total thermal and electric power output (MW): 330 Annual total fuel use (MWh): 1080789 Normal annual production of heat (MWh): 683388 Normal annual production of electricity (MWh): 314180 Degree of thermal efficiency (%): 92,3 PROCESS DESCRIPTION: The plant consists of one boiler unit. The thermal and electric power output, when peat or wood chips is incinerated, is 330 MW. The plant can also be fired with oil with a thermal and electric power output of 513 MW and coal with a thermal and electric power output of 335 MW. Only the incineration with peat is included in this study. The dust is removed from the flue gas in an electrostatic precipitator. The dust is then led to silos. The bottom ash is moistened and led to a container. INCLUDED OPERATIONS: The process study consists of the following operations: - The feeding of the pulverized peat into the combustion process. - The combustion process. - The removal of dust from the flue gas in the electrostatic precipitator. - The internal treatment of the residues from the combustion process. - The internal consumption of electricity. - The NOx control system. - Sulphur reduction system. NOx CONTROL: The boiler is equiped with SNCR system with urea as the reducing agent. - SNCR (Selective Noncatalytic Reduction) describes a method for reducing the NOx allready formed during the combustion process. In the process, an aqueous reduction agent mixed in water or steam is injected into the furnace during the combustion process. The reduction agent reduces the NOx and forms nitrogen and water. OTHER FLUE GAS CLEANING SYSTEMS: For the removal of dust from the flue gas an electrical precipitator is used. The plant is equipped with a dry flue gas cleaning system for the reduction of sulphur dioxide. Dolomite is added directly into the boiler, wherafter the dust and reaction products are separated in the electrostatic precipitator. After passage through a flue gas cooler, water and a mixture of separated ashes from the electrostatic precipitator and lime is added to the flue gas. Final flue gas cleaning take place in a dust filter bag. - In an electrostatic precipitator the dust particles are electrified and then separated from the flue gas stream by passing through an electric field with largest possible intensity. - In a dust filter bag the flue gas that contains dust is passed trough a tube made of felter cloth.

System Boundaries	
Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. The emission of HC is not measured.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.

Geographical Boundary	GEOGRAPHICAL EXTENSION (for large technical systems): This inventory has been conducted on a peat fired plant for heat production in Sweden, with swedish regulations, applicable during 1996. The collected data should only be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations has been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the internal electricity consumption. - The water consumption in the processes. - The breaking and refinement of the peat. - The transportation of the fuel to the plant. - The transportation of the residues from the combustion and cleaning processes to the landfill. - The processes at the landfill such as leaching, decomposition etc.
Allocations	PRINCIPLE APPLIED: In a combined power and heating plant two products of economic value are produced. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat and power respectively. For the use of resources and the emissions that are specific for the electric power production ar e allocated to that production. Equivalent to this the use of resources and the emissions specific for the heat production are allocated to that. Note: When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1994-01-25
Data Type	
Represents	See 'Function'
Method	All data reported are related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the avarage value for one our of an input (fuel, electricity etc.) to or an output (emission, product etc.) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the avarage amounts eith the avarage amount of produced heat. For some flows specific information is given, see each flow.
Literature Reference	Data are in general recieved from ''Miljörapport 1996, Uppsala Energi AB'' accept for emission data to air which are recieved from the periodical inspection report for the plant in 1994 whith peat as fuel.
Notes	The parameters presented are chosen because they are available in the annual environmental report or in the periodical inspection report. Data can be missing if it is not reported in the reports The type of data reported is governed by the inspection authority. The reason for using the data from the periodical inspection report for peat combustion is that the emissions reported in the annual environmental report are not seperated for each fuel used over the year. The periodical enspection was performed using only peat as fuel, while in the annual environmental report all data reported were for the total of both peat and wood chips combusted during the year. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: The consumed amount for the year. Literature: Miljörapport 1996, Uppsala Energi AB	Input	Refined resource	Ammonia	0.0002			l	Technosphere	
Method: The consumed amount for the year. Literature: Miljörapport 1996, Uppsala Energi AB	Input	Refined resource	Dolomite	6.08			g	Technosphere	
Method: Not known. Literature: Miljörapport 1996, Uppsala Energi AB	Input	Refined resource	Electricity	0.0461			kWh	Technosphere	
Method: The consumed amount for the year. Literature: Miljlörapport 1996, Uppsala Energi AB	Input	Refined resource	Hydrazine	0.0012			l	Technosphere	

Method: The consumed amount for the year. Literature: Miljörapport 1996, Uppsala Energi AB	Input	Refined resource	Hydrochloric acid	0.266			g	Technosphere	
Method: The consumed amount for the year. Literature: Miljörapport 1996, Uppsala Energi AB	Input	Refined resource	Lime	2.77			g	Technosphere	
Method: The consumed amount for the year. Literature: Miljörapport 1996, Uppsala Energi AB	Input	Refined resource	NaOH	0.0752			g	Technosphere	
Method: Calculated from the production during the periodical inspection and the specific heating value for peat (25,0 MJ/kg dry fuel). Literature: Periodical inspection 1994-01-25 - 1994-01-27, Uppsala Energi AB	Input	Refined resource	Peat	156			g	Technosphere	
Method: The consumed amount for the year. Literature: Miljörapport 1996, Uppsala Energi AB	Input	Refined resource	Urea	0.967			g	Technosphere	
Data type: Single sample Method: This emission was estimated by using the result from the periodical inspection. Literature: Periodical inspection 1994-01-25 - 1994-01-27, Uppsala Energi AB Notes: It was assumed that the result from the peridocal inspection represents the normal amount of emitted CO from the plant.	Output	Emission	CO	0.0812			g	Air	
	Output	Emission	CO2	295			g	Air	
Data type: Single sample Method: This emission was estimated by using the result from the periodical inspection. Literature: Periodical inspection 1994-01-25 - 1994-01-27, Uppsala Energi AB Notes: It was assumed that the result from the peridocal inspection represents the normal amount of emitted dust from the plant.	Output	Emission	Dust	0.045			g	Air	
Data type: Single sample Method: This emission was estimated by using the result from the periodical inspection. Literature: Periodical inspection 1994-01-25 - 1994-01-27, Uppsala Energi AB Notes: It was assumed that the result from the peridocal inspection represents the normal amount of emitted NOx from the plant.	Output	Emission	NOx	0.0159			g	Air	
Data type: Single sample Method: This emission was estimated by using the result from the periodical inspection. Literature: Periodical inspection 1994-01-25 - 1994-01-27, Uppsala Energi AB Notes: It was assumed that the result from the peridocal inspection represents the normal amount of emitted SO2 from the plant.	Output	Emission	SOx	0.2071			g	Air	
Method: Not known. Literature: Miljörapport 1996, Uppsala Energi AB	Output	Product	Heat	1			kWh	Technosphere	
Method: Calculated for an ash content of 5,9 % in peat and the consumption of peat per kWh heat.	Output	Residue	Ashes	9.20			g	Technosphere	

About Inventory

Publication	Data documented by: Maria Münter, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology

Intended User	Intended user of the data is t
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plant with different capacities.
Detailed Purpose	The specific purpose was to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory has been conducted on a peat fired plant for heat and power production in Sweden, with swedish regulations, applicable during 1996. The collected data should only be used for swedish conditions. This data should only be used on plants producing heat in Sweden and for swedish conditions. When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-controll and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own intrerest or as a consequence of an internal control program.
Notes	Combined heat and power plants are used as base primarily during the winter half, when the use of heat and power are the largest.

SPINE LCI dataset: PET

Administrative	
Finished	Y
Date Completed	1995
Copyright	
Availability	

Technical System	
Name	PET
Functional Unit	1 kg PET
Functional Unit Explanation	
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	The starting point for the commercial production of PET are ethylene for the production of ethylene glycol and para-xylene for the production of terephthalic acid. In practice there are two routes used in the production of PET precursors from p-xylene. Ethylene is produced by cracking either natural gas or the naphta fraction of crude oil. Before being used in the production of terephtalic acid, the different isomers of xylene are separated. Para-xylene is used in the production of PET because the ''straight'' chain structure is best suited to linear polymers.

	In practice, there are two routes used in the production of PET precursors from p-xylene. In the first, p-xylene is oxidised to terephthalic acid (TPA) which is then purified. This purified terephthalic acid is the reacted with etylene glycol to produce bishydroxyethyl terephthalate with water as a by-product. The alternative route oxidises p-xylene to terephthalic acid but then immediately reacts the acid with methanol to produce dimethyl terephthalate (DMT). When DMT is reacted with ethylene glycol, the result is bishydroxyethyl terephthalate as in the alternative route, but there is no a liberation of methanol rather than water. The methanol is recovered and re-used. The monomer from either route is then polymerised in the liquid phase to produce amorphous PET. This type of PET is suitable for the production of fibres and film. A second polymerisation in the solid state increases the molecular weight of the polymer and produces a partially crystalline resin that can be used to produce bottles via injection moulding and stretch blow moulding.

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	98/01/26
Data Type	Unspecified
Represents	See 'Function'
Method	Normal LCI method for the production of 1 kg of PET (from the cradle to the gate) The rough methodology is described in an another Eco-balance report called ''Methodology for commodity thermoplastics'' Dr Ian Boustead APME
Literature Reference	Eco-profiles of the European plastics industry Report 8 (07-1995) : Polyethylene terephthalate (PET) Association of Plastics Manufacturers in Europe Brussels - tel : +32 2 672 82 59
Notes	The parameters presented are chosen because they are available in the annual environmental report or in the periodical inspection report. Data can be missing if it is not reported in the reports The type of data reported is governed by the inspection authority. The reason for using the data from the periodical inspection report for peat combustion is that the emissions reported in the annual environmental report are not seperated for each fuel used over the year. The periodical enspection was performed using only peat as fuel, while in the annual environmental report all data reported were for the total of both peat and wood chips combusted during the year. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Bauxite	300			mg	Technosphere	Europe
	Input	Refined resource	Electricity	7.87			MJ	Technosphere	Europe
	Input	Refined resource	Heavy oil	45.65			MJ	Technosphere	Europe
	Input	Refined resource	Iron ore	500			mg	Technosphere	Europe
	Input	Refined resource	Limestone	250			mg	Technosphere	Europe
	Input	Refined resource	NaCl	4900			mg	Technosphere	Europe
	Input	Refined resource	Natural sand	20			mg	Technosphere	Europe
	Input	Refined resource	Other fuel	28.17			MJ	Technosphere	Europe
	Input	Refined resource	Water	17000000			mg	Technosphere	Europe
	Output	Emission	Acidification eq	160			mg	Water	Europe
	Output	Emission	Ashes	8700			mg	Technosphere	Europe
	Output	Emission	BOD	1000			mg	Water	Europe
	Output	Emission	Chlorides	710			mg	Water	Europe
	Output	Emission	CO	18000			mg	Air	Europe
	Output	Emission	CO2	2220000			mg	Air	Europe
	Output	Emission	COD	3100			mg	Water	Europe
	Output	Emission	Dissolved organics	13000			mg	Water	Europe

	Output	Emission	Dissolved solids	560			mg	Water	Europe
	Output	Emission	HC	390			mg	Water	Europe
	Output	Emission	HC	39000			mg	Air	Europe
	Output	Emission	HCl	100			mg	Air	Europe
	Output	Emission	Industrial waste	3500			mg	Technosphere	Europe
	Output	Emission	Metals	10			mg	Air	Europe
	Output	Emission	Metals	110			mg	Water	Europe
	Output	Emission	Mineral waste	27000			mg	Technosphere	Europe
	Output	Emission	Na+	1500			mg	Water	Europe
	Output	Emission	NOx	19000			mg	Air	Europe
	Output	Emission	Oil	20			mg	Water	Europe
	Output	Emission	Organic compounds	9300			mg	Air	Europe
	Output	Emission	Particles	3500			mg	Air	Europe
	Output	Emission	SOx	23000			mg	Air	Europe
	Output	Emission	Sulphates	40			mg	Water	Europe
	Output	Emission	Susp solids	550			mg	Water	Europe
	Output	Product	PET	1			kg	Technosphere	Europe
	Output	Residue	Inert chemicals	1600			mg	Technosphere	Europe
	Output	Residue	Regulated chemicals	130			mg	Technosphere	Europe

About Inventory

Publication	Eco-profiles of the Eurpean plastics industry Report 8 : Polyethylene Terephthalate (PET) APME technical report 07 1995 -- Data documented by: Sophie Louis, Volvo Technical Development Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	APME's eco-profiles serve two
General Purpose	There is an increasing demand concerning LCA data. Following this trend, APME members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of PET
Commissioner	- APME, Avenue E. Van Nieuwenhuyse 4 Box 3 B-1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	The process examined here exists in Italy, Germany, the Netherlands and the United Kingdom. In the calculations, the fuel producing industries corresponding to the specific country have been used based on the data reported by the OECD.
About Data	The starting point for the commercial production of PET are ethylene for the production of ethylene glycol and para-xylene for the production of terephthalic acid. In practice there are two routes used in the production of PET precursors from p-xylene. Data have been collected from the producers of 160 000 tonnes of PET of which approximately 80 per cent is produced by the terephthalic acid route; the remainder is produced from dimethyl terephthalate. All data refer to a 12 month period during 1989 to 1991. Unlike the earlier reports in the series, the number of producers of PET and its immediate precursors is small and for these reasons the CEFIC rules on provision of statistics have been applied.
Notes	

SPINE LCI dataset: Phosphatising of cast iron rings

Administrative

Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System

Name	Phosphatising of cast iron rings
Functional Unit	9.604 kg guide ring
Functional Unit Explanation	One guide ring of this specific model (RG-232/530 C/243475) weighs 9,604 kg. This dataset decribes inflows and outflows from a phosphatising process related to this guide ring. The guide ring will be mounted into an SKF Spherical roller bearing 232/530.
Process Type	Gate to gate
Site	SKF Mekan ABBox 89 641 21 Katrineholm
Sector	Materials and components
Owner	SKF Mekan ABBox 89 641 21 Katrineholm
Technical system description	This activity describes a process step included in the whole system activity ''Production of guide rings used for spherical roller bearings''', also available in the SPINE@CPM database. The guide ring is manufactured at SKF Mekan AB in Katrineholm and the process consists of several steps. See the activity ''Production of guide rings used for spherical roller bearings'' for details. The guide ring will finally be mounted into the SKF Spherical Roller Bearing 232/530. The function of the guide ring is to assure that the rollers stay in the raceways of the bearing. The guide ring is made of cast iron, produced mainly from scrap. After smelting of the raw materal the smelt iron is casted in a sand form. The cast iron is then further processed into guide rings. This dataset describes the phosphatising of the cast iron rings after the casting process. ------------------------- Phosphatising of cast iron rings: When the ring has been turned into its final shape, it is phosphatised. This is done to protect the surface from corrosion by adding rust inhibitors. First the ring is defatted in a highly alkaline bath. Then it is washed and treated in a bath with phosphoric acid. Finally it is treated in an oil-bath with corrosion protective agents and dried. All mentioned process steps are included in this data set.

System Boundaries

Nature Boundary	Many of the chemicals used in the turning process are not followed from the cradle, since it was too time consuming and the impact was assumed to be very small since the total amount was very small and the substances according to product data sheets not were considered hazardous. These inflows are considered non-elementary and come from the technosphere. Emissions to air and water are not included in this dataset since no information was available.
Time Boundary	The data was collected during the autumn 2002 and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The phosphatising process take place in the maintreatment (KV) at SKF Mekan AB in Katrineholm, Sweden.
Other Boundaries	The energy needed to keep the temperature in each bath is NOT included in this study, since no information was available.
Allocations	Allocations have been made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'

Method	Data has been gathered from interviews and supplied material from Marja Andersson, SKF Mekan AB, in Katrineholm. She is responsible for environmental questions and much of the data comes from the environmental report from year 2001. All product data sheets for the different chemicals used were supplied by Marja Andersson, but since it was too time consuming, these inflows are not traced back to the cradle, but is set as non/elementary inflows from the technosphere.
Literature Reference	Eco-profiles of the European plastics industry Report 8 (07-1995) : Polyethylene terephthalate (PET) Association of Plastics Manufacturers in Europe Brussels - tel : +32 2 672 82 59
Notes	The parameters presented are chosen because they are available in the annual environmental report or in the periodical inspection report. Data can be missing if it is not reported in the reports The type of data reported is governed by the inspection authority. The reason for using the data from the periodical inspection report for peat combustion is that the emissions reported in the annual environmental report are not seperated for each fuel used over the year. The periodical enspection was performed using only peat as fuel, while in the annual environmental report all data reported were for the total of both peat and wood chips combusted during the year. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Antifoam SE is an aqueous solution of polymers. No substances are hazardous according to the product data sheet.	Input	Refined resource	Antifoam SE	0.011294304			l	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Bonder 202A consists of: Phosphoric acid: 0-3.6% NiNO3: 0.1-1% ZnNO3: 10-30% H2O: ZnPO4: 10-30% according to the product data sheet.	Input	Refined resource	Bonder 202A	0.006778503			kg	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Bonder 202E has the same content as Bonder 202A, except for a small amount of HNO3 (0.1-1%) according to the product data sheet.	Input	Refined resource	Bonder 202E	0.020341272			kg	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Gardorol CP 8010 consists of mineral oil with 0-2.4 % CASnr: 112-34-5 0-2.4 % CASnr: 110-90-7 according to the product data sheet The function = rust inhibitor in the last oil bath.	Input	Refined resource	Gardorol CP 8010	0.04744376			l	Technosphere	
	Input	Refined resource	Guide ring	9.604			kg	Technosphere	Sweden
	Input	Refined resource	H2O	6.7931			kg	Water	Sweden
	Input	Refined resource	HCl	0.004067582			kg	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Rimitanol TFA 17 consists of: CAS nr: Concentration: 9003-05-8 5-10% 79-06-1 <0.1% according to the product data sheet.	Input	Refined resource	Rimitanol TFA17	0.006778503			l	Technosphere	
	Input	Refined resource	Sodium hydroxide	0.003559242			kg	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Ytex 1610 consists of: CAS nr: Concentration: 25155-30-0 1-3% 61791-14-8 1-3% 6834-92-0 10-30% 497-19-8 10-30% according to the product data sheet. The function = defattening agent before the phosphatising bath.	Input	Refined resource	Ytex 1610	0.04292988			kg	Technosphere	
	Output	Product	Guide ring	9.604			kg	Technosphere	Sweden
	Output	Residue	Sludge	0.0105			kg	Technosphere	Sweden

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for phosphatised cast iron rings at the specific site at SKF Mekan AB in Katrineholm, Sweden.
About Data	Data is gathered from interviews with Marja Andersson, SKF Mekan AB, Katrineholm.
Notes	

SPINE LCI dataset: Pickled hot rolled steel sheet

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Pickled hot rolled steel sheet
Functional Unit	1 kg pickled hot rolled steel sheet
Functional Unit Explanation	Before the steel can be coated, different pre treatments has to be done. The steel from the steel mill is first hot rolled and then pickled. After the pickling process, the steel is cold reduced and then finally coated.
Process Type	Gate to gate
Site	SSAB Tunnplåt
Sector	
Owner	SSAB Tunnplåt
Technical system description	This activity describes a process step included in the system ''Production of plywood boxes'', also available in the SPINE@CPM database. Plywood boxes are used to pack the coated and non-coated roller bearings from SKF, Göteborg, during the transportation to customers. The plywood boxes are manufactured by Nefab Emballage AB in Alfta, Sweden. The plywood box consist of plywood, steel strips, steel nails and wooden splits. The steel for the steel strips and steel nails is hot rolled, pickled, cold reduced and finally coated at SSAB Tunnplåt`s line in Borlänge. This dataset describes the production of 1 kg pickled hot rolled steel sheet at SSAB Tunnplåt AB in Borlänge. The environmental profile refers to the mean values of emissions to which the pickling lines

	and recovery of hydrocloric acid give rise in the production of pickled hot rolled steel sheet. All data for the process is obtained from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. The data refers to an existing EPD from SSAB Tunnplåt AB: Environmental Product Declaration from SSAB; SE 381; July 1999

System Boundaries

Nature Boundary	Emissions to air and water are included. The steel scrap from the process is reused as raw material and is thus not considered as waste, but as a co-product ending in the technosphere. The hydrochloric acid used in the process is recovered. For more detailed information see the EPD SE 381 from SSAB Tunnplåt AB.
Time Boundary	This environmental profile refers to the mean values of emissions to which the pickling lines and recovery of hydrochloric acid give rise in the production of pickled hot rolled steel sheet at SSAB Tunnplåt AB in Borlänge during the years 1998-1999. Changes in the process since then are not known.
Geographical Boundary	The hot rolling of steel sheet takes place at SSAB Tunnplåt´s line in Borlänge, Sweden.
Other Boundaries	The production of electricity is NOT included in the dataset, but must be followed from the cradle in order to obtain the total environmental impact. This must also be done with the production of LPG.
Allocations	Allocations have been made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'
Method	All data for the process is obtained from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. The data refers to an existing EPD from SSAB Tunnplåt AB: Environmental Product Declaration from SSAB; SE 381; July 1999.
Literature Reference	illvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. Environmental Product Declaration from SSAB; SE 381; July 1999.
Notes	The parameters presented are chosen because they are available in the annual environmental report or in the periodical inspection report. Data can be missing if it is not reported in the reports The type of data reported is governed by the inspection authority. The reason for using the data from the periodical inspection report for peat combustion is that the emissions reported in the annual environmental report are not seperated for each fuel used over the year. The periodical enspection was performed using only peat as fuel, while in the annual environmental report all data reported were for the total of both peat and wood chips combusted during the year. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	0.005			kWh	Technosphere	Sweden
	Input	Refined resource	HCl	0.9			g	Technosphere	Sweden
	Input	Refined resource	Hot rolled steel sheet	1.025			kg	Technosphere	Sweden
	Input	Refined resource	LPG	0.02			kWh	Technosphere	Sweden
	Output	Co-product	Steel scrap	25			g	Technosphere	Sweden
	Output	Emission	CO2	5			g	Air	Sweden
	Output	Emission	Dust	5			mg	Air	Sweden
	Output	Emission	Iron	0.1			mg	Water	Sweden
	Output	Emission	NOx	6			g	Air	Sweden
	Output	Emission	Particles	0.5			mg	Water	Sweden
	Output	Product	Pickled steel sheet	1			kg	Technosphere	Sweden
	Output	Residue	Solid	0.1			g	Technosphere	Sweden

About Inventory

Publication	Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. Both types of bearings are packed in a plywood box. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The dataset is applicable to the production of 1 kg pickled to rolled steel sheet at SSAB Tunnplåt AB in Borlänge.
About Data	All data for the process is obtained from an earlier LCA study at Nefab Emballage AB: Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. The data refers to an existing EPD from SSAB Tunnplåt AB: Environmental Product Declaration from SSAB; SE 381; July 1999.
Notes	

SPINE LCI dataset: Pine window production. ESA-DBP

Administrative	
Finished	Y
Date Completed	2000
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Pine window production. ESA-DBP
Functional Unit	1 pine window
Functional Unit Explanation	Not applicable.
Process Type	Cradle to gate
Site	Not applicable
Sector	Materials and components
Owner	Not applicable
Technical system description	Excerpt from the report (see 'Publication'): ''Elit Fönster ''H'' pine window. Single-light type, pivoted with a triple-glazed insulated unit with a low E glass and a modular size of 12x12 M. The window is constructed with casement and frame impregnated wood and is factory painted.'' This process is included in the system described in: Blanco-Rosete S. R., 2002, LCA data structure and time series related to construction and maintenance in Sweden. Environmental Systems Analysis report 2002:14, Chalmers University of Technology, Gothenburg, Sweden

	Other processes in the CPM Database also included in the above publication: Swedish red paint manufacturing and application. ESA-DBP Clay roof tile manufacturing. ESA-DBP Exterior coating (Swedish red paint) maintenance. ESA-DBP Floor maintenance. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	2000
Geographical Boundary	Sweden
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2000
Data Type	Unspecified
Represents	See 'Function'.
Method	Data was taken from an Environmental Declaration.
Literature Reference	Norén J, 2000, Environmental declaration. Elit Fönster ''H'' window. The Nordic Timber Industry, Sweden
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Resource	Bauxite	0.05143			kg	Ground	
	Input	Resource	Coal	0.08857			kg	Ground	
	Input	Resource	Halite	2.86E-05			kg	Ground	
	Input	Resource	Iron ore	0.1429			kg	Ground	
	Input	Resource	Limestone	0.05143			kg	Ground	
	Input	Resource	Pine	2.143			kg	Ground	
	Output	Emission	Ashes	4			g	Ground	
	Output	Emission	CO	13.89			g	Air	
	Output	Emission	CO2	640			g	Air	
	Output	Emission	COD	6.629			g	Water	
	Output	Emission	Dissolved solids	0.07143			g	Water	
	Output	Emission	Dust	1.714			g	Air	
	Output	Emission	Hydrochloric acid	0.03429			g	Air	
	Output	Emission	Metals	0.08857			g	Water	
	Output	Emission	Methane	0.7714			g	Air	
	Output	Emission	NOx	8.657			g	Air	
	Output	Emission	N-tot	0.01143			g	Water	
	Output	Emission	PAH	0.000857			g	Air	
	Output	Emission	P-tot	0.005714			g	Water	
	Output	Emission	SO2	3.771			g	Air	
	Output	Emission	Suspended solids	0.08857			g	Water	
	Output	Emission	Terpenes	1.057			g	Air	
	Output	Emission	VOC	17.97			g	Air	
	Output	Product	Window	1			pce	Technosphere	
	Output	Residue	Hazardous waste	1.914			g	Technosphere	
	Output	Residue	Industrial waste	25.54			g	Technosphere	

About Inventory

Publication	Blanco-Rosete S. R., 2002, LCA data structure and time series related to construction and maintenance in Sweden. Environmental Systems Analysis report 2002:14, Chalmers University of Technology, Gothenburg, Sweden

Intended User	LCA practitioners.
General Purpose	This process data set is recalculated to fit in the Master Thesis given in 'Publication'. Excerpt from the report (see 'Publication'): ''Construction, building maintenance and housing management contribute to a large extent to the environmental impact. When housing owners and managers perform their activities they should be aware of the environmental effects they cause. The environmental impact of existing houses could be addressed and diminished within the possibilities of a clever management.''
Detailed Purpose	Excerpt from the report (see 'Publication'): ''This master thesis descibes and defines a building system model for a multi-family house in Gothenburg over a 30 year period from 1970 to 2002 . The model was used to collect environmental impact information regarding materials or products used in the construction and maintenance of a building . The environmental impact ofa a multi-family house was evaluated through a Life Cycle Assessment (LCA). Finally to account the long sevice lifetime of a multi-family house two case studies were carried out to test if the use of Time series can illustrate the environmental impact of maintenance activities caused by decisionmaking in housing management.''
Commissioner	Not applicable - .
Practitioner	Sergio R. Blanco-Rosete - .
Reviewer	Birgit Brunklaus - Environmental Systems Analysis
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpt from the report (see 'Publication'): ''Data was taken from an Environmental declaration. The inventory of the study includes from the extraction of raw materials to the window production. ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-09-21 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Planting softwood plants

Administrative	
Finished	Y
Date Completed	1994-02-24
Copyright	None
Availability	Public

Technical System	
Name	Planting softwood plants
Functional Unit	Hectare
Functional Unit Explanation	Hectare planted forest land
Process Type	Gate to gate
Site	Sweden
Sector	Forestry
Owner	Sweden

Technical system description	Planting tree seedlings includes transport of tree plant to the forest and plantation. The transport is done by a truck transporting the plants from the plant nursery to the forest (40000 plant per truckload) and by a tractor in the forest (30kW). The plantation is done manually using a plantation tube (planteringsrör).and demands labor to be transported to the forest (a car takes the shift to the forest: 0,10 l diesel/km).

System Boundaries

Nature Boundary	The silviculture belongs to the system Emissions caused by combustion of diesel is not included.
Time Boundary	A gradual exchange of old machinery into newer, will decrease fuel consumption.
Geographical Boundary	Sweden
Other Boundaries	N/A
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	94-02-24
Data Type	Unspecified, expert outspoke
Represents	Representing Swedish average
Method	Data derived from Staffan Berg, Skogforsk. Further description is available for each specific flow.
Literature Reference	Norén J, 2000, Environmental declaration. Elit Fönster ''H'' window. The Nordic Timber Industry, Sweden
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Derrived from the step: Clearing of ground.	Input	Refined resource	Cultivated forest area	1			ha	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Represents: Transport to forest. One truck is transporting 40 000 plants in average 50 km uing 0,28 l diesel per km, giving 12,5 MJ/1000 plants. Transport of plants from road to planting site: 3300 plants are transported 300 m uing 30 kW diesel powered tractor. With a speed of 50 m/min, the total distance of 600 m takes 0,2 h. 0,2 h*30KW*3,6 MJ/kWh/3300 pl = 6,5 MJ/1000 pl. In this case 2300 pl/shift are planted. Personell transport to plantation: 2*20 km*0,10 l diesel/km = 61,9 MJ/1000 pl Totally 80,9 MJ diesel/1000 pl = 194,2 MJ/ha (assuming 2400 pl/ha)	Input	Refined resource	Diesel	194			MJ	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: A 30 kW gasoline engined tractor transports 3300 plants in average 300 meters. Velocity: 50 m/min. The total distans (600 m) takes 12 minutes, or 0,2 hours. 0,2 h * 30 kW * 3,6 MJ/kW / 3300 plants = 6,5 MJ/ 1000 plants, or 15,84 MJ/2400 plants.	Input	Refined resource	Gasoline	15.84			MJ	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Derrived from the step: Plant nursery activities.	Input	Refined resource	Tree plants	2400			pce	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke	Output	Product	Planted forest area	1			ha	Technosphere	Sweden

About Inventory	
Publication	None -- Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose is to supply with LCA-data for forestry to be used in further studies of wood products.
Detailed Purpose	Update of earlier studies of forestry.
Commissioner	- Stora Corporate Research, Box 601 661 29 Säffle Sweden.
Practitioner	Swan, Göran - Stora Corporate Research, Box 601, S-661 29 Säffle, Sweden.
Reviewer	
Applicability	These data are valid for large scale nursery in forestry. It is important to check the type of fuel used. In this case, fossil fuel is assumed to be used. Other data is available from other forest companies, or from Skogforsk, or STFI. The silviculture process in Sweden has eight steps: 1. Plant nursing 2. Soil preparation 3. Planting 4. Clearing 5. Thinning 6. Fertilizing 7. Final felling 8. Forwarding This is the third step. Forestry is also depending on natural regeneration, where the steps plant nursing, soil preparation and planting would be excluded. Approximately 20% (1997) of the total forest area is regenerated naturally.
About Data	These data depend to a great extent to which LCA-data on diesel and gasoline use that are used. The transport distances are representing a swedish average and may be greater in the northern part of Sweden.
Notes	

SPINE LCI dataset: Plasterboard production

Administrative	
Finished	Y
Date Completed	1997-05-01
Copyright	
Availability	Public

Technical System	
Name	Plasterboard production
Functional Unit	kg
Functional Unit Explanation	1 kg plasterboard
Process Type	Cradle to gate

Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	Limestone and plaster stone is extracted and mixed with scrap of plasterboards. It is heated and mixed with additives, pressed to boards, hardened and dried. This set of data is calculated for the type of plasterboard that is called Gyproc GN13.

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Unspecified
Represents	Representing Swedish average
Method	Study literature data. Due to changes in production processes and material proportions, Lars Riis, Gyproc AB has revised the inventory data during 1996.
Literature Reference	Sundberg K. Miljökonsekvenser av byggnadsmaterial. Gipsskivan - en livscykelanalys (Environmental consequences of building materials. Gypsum board - a life cycle assessment) TRITA-BYMA Rapport 1994:1
Notes	The data is summarized by Thomas Björklund and Ann-Marie Tillman (Technical Environmental Planning, CTH, 412 96 Göteborg, Sweden) during the spring 1997 in LCA of Building Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Report 1997:2, but the sources are probably a few years older.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Additives	4.8			g	Technosphere	
	Input	Refined resource	Diesel	0.73			MJ	Other	
	Input	Refined resource	Electricity	0.58			MJ	Other	
	Input	Refined resource	Gypsum	952			g	Other	
	Input	Refined resource	Oil	2.12			MJ	Other	
	Input	Refined resource	Paper	49			g	Technosphere	
	Output	Emission	BOD	0.24			g	Water	
	Output	Emission	CO	0.19			g	Air	
	Output	Emission	CO2	216.53			g	Air	
	Output	Emission	COD	0.49			g	Water	
	Output	Emission	HC	0.14			g	Air	
	Output	Emission	NOx	6.3			g	Air	
	Output	Emission	N-tot	0.003			g	Water	
	Output	Emission	Particles	0.14			g	Air	
	Output	Emission	SO2	1.89			g	Air	
	Output	Emission	Susp solids	0.04			g	Water	
Notes: Gyproc GN13 contains (weight %): Gypsum (95.2), Cardboard (4.9), Starch (0.3), Foam medium (0.07), Dispersion medium (0.05), Glue (0.03), Glass-fiber (0.03), Vermiculite & Kaolin	Output	Product	Plasterboard	1			kg	Technosphere	

(-).									
	Output	Residue	Ashes	0.02			g	Other	
	Output	Residue	Industrial waste	4.67			g	Other	

About Inventory

Publication	LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund, Tillman; Report 1997:2; TEP; CTH; Göteborg; Sweden --- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology ---
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural wooden and concrete frames in buildings during the whole life-cycle, by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of plasterboard
Commissioner	- Finncement Finland .
Practitioner	Björklund Thomas, Tillman Anne-Marie - Technical Environmental Planning, CTH 412 96 Göteborg Sweden.
Reviewer	
Applicability	This set of data is calculated for the type of plasterboard that is called Gyproc GN13, but both Gyproc U and Protect F may be substituted with the environmental data of Gyproc GN13. Three types of plasterboards are used in the wooden frame: Gyproc U, Gyproc GN13 and Gyproc Protect F. The first board is a thinner (9 mm) variant of the normal board which is 13 mm. The last board is a special fire protection board with a higher content of fiberglass; the last board also has a thickness of 15 mm and two other materials are included. The basis weight for Gyproc GN13 is 9 kg/m2; 12,5 kg/m2 for the Protect F board and 7,2 kg/m2 Gyproc U board. The difference in raw materials used, for Gyproc GN13 and Protect F, is presented below. Gyproc GN13 contains (weight %): Gypsum (95.2), Cardboard (4.9), Starch (0.3), Foam medium (0.07), Dispersion medium (0.05), Glue (0.03), Glass-fiber (0.03), Vermiculite & Kaolin (-). Protect F contains (weight %): Gypsum (86), Cardboard (3), Starch (0.3), Foam medium (-), Dispersion medium (0.2), Glue (<0.1), Glass-fiber (0.3), Vermiculite & Kaolin (10). The principal difference between the GN-board and the Protect 7 F board is the amount of gypsum used and the occurrence of Vermiculite and Kaolin in the Protect F board. The environmental load of the latter substances may be approximated to the data for mining of some sort, gypsum for instance, hence environmental wise no great difference exists. Because of this, both Gyproc U and Protect F may be substituted with the environmental data of Gyproc GN13. The function of the technical system is not sufficently described. Contact Gyproc AB Box 505 201 25 Malmö Sweden Phone +46 -40 165600 to get the necessary details.
About Data	
Notes	

SPINE LCI dataset: Plastic waste incineration

Administrative

Finished	Y
Date Completed	2003-03-10
Copyright	
Availability	Public

Technical System

Name	Plastic waste incineration
Functional Unit	1 kg of plastic wastes
Functional Unit Explanation	1 kg of plastic wastes incinerated in the fluidized bed with energy recovery.
Process Type	Gate to grave
Site	Germany
Sector	Waste treatment
Owner	Germany
Technical system description	This data set represents the incineration of plastics collected by the Duales System Deutschland AG. The system studied starts with the collection and sorting of used packaging. The recycling scenario assumes that packaging wastes are collected from the consumer via a collection truck and transported to the sorting plant over an average distance of 80 km. The power consumption required for sorting is 40 kWh per tonne input. The sorting residues are landfilled. Landfilling of sorting residues and hazardous wastes (filter dust from fluidised bed combustion process) is included in the system. The plastic wastes are then transported over a distance of 200 km from the sorting plant to use in fluidized bed combustion and reduced in size with a power consumption of 200 kWh per tonne. The resulting material is used as a fuel in a fluidized bed kiln with a flue gas precipitation. The mass percentage of plastic wastes is as follows: Films: 9,0% Bottles: 7,5% Mixed plastics: 58,4% Sorting residue: 25,1% For the calculation of the mass balance of the combustion process, all input components of the furnace are split into their chemical composition. The calorific values are calculated from the elementary composition of plastic wastes. With the steam quality assumed (40 bar), an efficiency for electricity production of 17% is possible (steam reduction to 4 bar). Incineration of 1 kg of plastic waste thus yields 1,27 kWh electricity. The remaining steam (22,4 MJ) is assumed to be used completely. Literature reference: Recycling and Recovery of Plastics from Packagings in Domestic Waste. LCA-type analysis of different strategies. Michael Heyde, Markus Kremer. Institut Verfahrenstechnik und verpackung (IVV). Vol. 5. 1999 For more literature references see: ''About data''.

System Boundaries

Nature Boundary	The emissions to air and ground are included in the system. The input streams to the system are waste input, combustion air, auxiliary materials and energy for flue gas cleaning. Output streams leaving the system as solid materials are bed ash and boiler ash from the furnace and the residues from flue gas cleaning. The emissions to the atmosphere contained in the clean gas come from the flue gas purification.
Time Boundary	The data collection was performed in the period from 1993 to 1994. The study was reviewed and published in 1999. The data on transportation (distance, fuel demand, transport emissions) were collected in 1993. The data on sorting were collected from plant operators in 1994. The data on heat from natural gas boiler and grid power are collected in 1992.
Geographical Boundary	The study uses a wealth of data that appear to represent existing conditions of site-specific operations of the technically available recycling technologies in German at the time of the study.
Other Boundaries	The auxiliary materials used for the flue gas precipitation in the waste incineration plant are NaOH, ammonia and activated coke. The energy required for supplying these materials (0,3 MJ) is included in the balance. The auxiliary materials for the flue gas precipitation account for less than 3 wt% of the input of the waste to the incineration plant.

	The non-burnable components introduced into the system along with the fuel are precipitated as filter dust in fluidized bed combustion. Due to the high contamination with heavy metals, the filter dust must go to landfill for hazardous waste. The landfill for hazardous waste is considered to be free of emissions. The transport to landfill for hazardous waste is included in the system. It is assumed that there is a transport distance of 100 km to the landfill for hazardous waste.
Allocations	Not applied.
Systems Expansions	The electricity produced in the waste incineration is fed into the national grid. Electricity produced from plastics waste incineration is considered as a substituting electricity, which otherwise had to be produced from the primary energy carrier mix for German public grid. For the steam produced the substitution of steam from a natural gas heating station is assumed. The selected plant represents the state of art and meets German legal requirements on air-pollution control. The substitution factor used is 1 to 1. The waste incineration plant covers its own steam and power requirements, so that these must be substracted from the quantity of steam and power produced.

Flow Data

General Activity QMetaData

Date Conceived	20021010/20030110
Data Type	Derived, mixed
Represents	Representing Swedish average
Method	Plastic wastes are incinerated as monofuel in the fluidised bed combustion. The data derived from literature and from incineration tests in Wurzburg, Germany.
Literature Reference	Recycling and Recovery of Plastics from Packagings in Domestic Waste. LCA-type analysis of different strategies. Michael Heyde, Markus Kremer. Institut Verfahrenstechnik und verpackung. Vol. 5. 1999
Notes	The data is summarized by Thomas Björklund and Ann-Marie Tillman (Technical Environmental Planning, CTH, 412 96 Göteborg, Sweden) during the spring 1997 in LCA of Building Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Report 1997:2, but the sources are probably a few years older.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Data type: Derived, mixed Method: For the spicified input composition the stoichiometric air requirement was calculated. The air excess is 1,4-1,5. Notes: combustion air	Input	Natural resource	Air	-17.7			kg	Air	
Represents: Electricity produced from plastic waste incineration substitutes primary energy carrier mix for the German public grid. (see System expansion) Notes: Used for electricity production	Input	Natural resource	Crude gas	-0.0053			m3	Ground	
Represents: Electricity produced from plastic waste incineration substitutes primary energy carrier mix for the German public grid. (see System expansion) Notes: Used for electricity production	Input	Natural resource	Crude oil	-0.0377			kg	Ground	
	Input	Natural resource	FeCl3	-0.01			g	Ground	
Represents: Electricity produced from plastic waste incineration substitutes primary energy carrier mix for the German public grid. (see System expansion) Notes: Used for electricity production	Input	Natural resource	Hard coal	-0.0365			kg	Ground	
Represents: Electricity produced from plastic waste incineration substitutes primary energy carrier mix for the German public grid. (see System expansion) Notes: raw lignite used for electricity production: Hu: 8,324 MJ/kg = -0.0411 kg Hu: 8,795 MJ/kg = -0.0892 kg Hu: 9,5 MJ/kg = -0.0272 kg	Input	Natural resource	Lignite	-0.1575			kg	Ground	

	Input	Natural resource	NaOH	-0.0125			kg	Ground	
Represents: Electricity from other fuels (without direct environmental impact) Notes: Incineration of 1 kg of plastic waste yields 1,27 kWh electricity.	Input	Refined resource	Electricity	-0.0038			kWh	Technosphere	
Represents: Electricity produced from plastic waste incineration. Substitutes primary energy carrier mix for the German public grid. (see System expansion) Notes: Primary equivalent of uranium ore.	Input	Refined resource	Electricity	-0.507			kWh	Technosphere	
Notes: Without direct environmental impact	Input	Refined resource	Hydro energy	-0.0216			kWh	Technosphere	
	Input	Refined resource	Plastic waste	1			kg	Technosphere	
Notes: Process and boiler feed water	Input	Refined resource	Water	-0.00073			m3	Technosphere	
Data type: Derived, mixed Method: The proportion of bed ash was on average 3% of the total amount of ash (according to experimental results from a pilot plant operated by Ahlstrom). The remaining 97% are fly ash and raw gas.	Output	Emission	Ashes	3.73			g	Ground	
	Output	Emission	Cd	0.000083			g	Air	
	Output	Emission	CH4	0.63			g	Air	
Data type: Derived, mixed Method: Emissions of CO are assigned due to the amount of the flue gas volume. Literature: The data derived from the literature and from incineration tests in Wurzburg.	Output	Emission	CO	0.4			g	Air	
Method: Calculated on the basis of the oxidation of the input substances.	Output	Emission	CO2	2770			g	Air	
	Output	Emission	Dust	0.046			g	Air	
	Output	Emission	Dust	138			g	Ground	
	Output	Emission	Hazardous waste	3.66			g	Ground	
Method: Calculated on the basis of the literature data.	Output	Emission	HCl	0.13			g	Air	
	Output	Emission	Heavy metals	0.0022			g	Air	
Method: Calculated on the basis of the literature data.	Output	Emission	HF	0.0033			g	Air	
	Output	Emission	Hg	0.000017			g	Air	
Method: Calculated on the basis of the oxidation of the input substances.	Output	Emission	N2	13.4			kg	Air	
	Output	Emission	Noble gases	15.8			g	Air	
Method: Emissions of NOx are assigned due to the amount of the flue gas volume. Literature: The data derived from the literature and from incineration tests in Wurzburg.	Output	Emission	NOx	3			g	Air	
Method: Calculated on the basis of the oxidation of the input substances.	Output	Emission	O2	1.23			kg	Air	
Method: Calculated on the basis of the literature data.	Output	Emission	SO2	1.06			g	Air	
Method: Emissions of TOC are assigned due to the amount of the flue gas volume. Literature: The data derived from the literature and from incineration tests in Wurzburg.	Output	Emission	Total organic carbon	0.018			g	Air	
	Output	Emission	Water vapour	2.11			kg	Air	
	Output	Emission	VOC	0.046			g	Air	
Notes: power station ash	Output	Residue	Ashes	8.68			g	Technosphere	

About Inventory

Publication	Recycling and Recovery of Plastics from Packagings in Domestic Waste. LCA-type analysis of different strategies. Michael Heyde, Markus Kremer. Institut Verfahrenstechnik und verpackung (IVV). Vol. 5. 1999 -- Data inserted by: Anastassia Manuilova. Chalmers University of Technology and Akzo Nobel Surface Chemistry AB. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-05-28
Intended User	LCA practitioners in industry,
General Purpose	To evaluate the existing and principally available recycling processes for plastic wastes, and determine the environmental impacts from the processes.
Detailed Purpose	The goal of the study is to inform public and governmental authorities about environmental implications of recycling and recovery processes, which are already used or principally available for the treatment of plastics waste. And to provide scientific information as a prerequisite for a comparison of these recycling and recovery processes. The data were used in the Master of Science thesis work ''Life Cycle Assessment of Industrial Packaging for Chemicals''. Anastassia Manuilova. Chalmers University of Technology and Akzo Nobel Surface Chemistry AB. 2003. The overall aim of the study was to evaluate the potential environmental effect of steel and plastic packaging used at Akzo Nobel site Stenungsund over the entire life cycle with emphasis on reuse and recycling.
Commissioner	- Akzo Nobel Surface Chemistry AB 444 85 Stenungsund Sweden.
Practitioner	Manuilova, Anastassia - Akzo Nobel Surface Chemistry Environmental Development S-444 85 Stenungsund Sweden.
Reviewer	
Applicability	The results are in line with similar European studies. While the technologies analyzed appear to be applicable in other parts of Europe, upon closer inspection, the data supporting the environmental profile presented and the regulatory context originate from many specific German situations. This is particularly true for the data on transport, electricity generation and the performance of incineration. As a result, the relative environmental profiles of the processes studied could vary significantly if set other European contexts. Therefore, while very useful, the result of the study can only be applied to the rest of Europe if the local site-specific conditions are taken into account.
About Data	The data records used are based on measurement made on MSWI Wurzburg plant (empirically measured data adapted to the standard input of the study via model calculations in agreement with plant operators). The data on which calculation is based were collected in the years 1993-1994. The plant (MSWI Wurzburg) on which measurements were made corresponds to the state of the art and to the legal requirements. [IVV, 1999], [APME1, 1994], [APME2, 1994] The data on heat from natural gas boiler and grid power are collected in 1992 and come from [GEMIS] and other sources. The data on sorting are based on interviews with plant operators and were collected in 1994. [Heyde, 1994] The data on transport emissions and landfill are extracted from literature. The references mentioned above: [IVV, 1999] - Recycling and Recovery of Plastics from Packagings in Domestic Waste. LCA-type analysis of different strategies. Michael Heyde, Markus Kremer. Institut Verfahrenstechnik und verpackung (IVV). Vol. 5. 1999. [APME1, 1994] - Mark, F et al.: Energy Recovery - Through Co-Combustion of Mixed Plastic Waste and Municipal Solid Waste; APME-report, Brussels. 1994. [APME2, 1994] - Mark, F et al.: MSW Combustion; Effects of Mixed Plastic Waster Addition on Solid Residues and Chlorinated Organic Compounds; APME-report, Brussels. 1994. [GEMIS] - Fritsche, U. et al.: Gesamtemissionsmodell Integrierter Systeme (GEMIS) - Version 2.0, Endbericht mit Datenbank. Hrsg.: Hessisches Ministerium fur Umwelt, Energie und Bundesangelegenheiten, Wiesbaden, 1992. [Heyde, 1994] - Heyde, M.; Schonert, M.: Sortierung von Leichtverpackungen, Studie des Fraunhofer Instituts fur Lebensmitteltechnologie und Verpackung, Munchen, 1994.
Notes	The data were used in the Master of Science thesis work ''Life Cycle Assessment of Industrial Packaging for Chemicals''. Anastassia Manuilova. Chalmers University of Technology and Akzo Nobel Surface Chemistry AB. 2003.

SPINE LCI dataset: Plywood production

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Plywood production
Functional Unit	1 kg plywood
Functional Unit Explanation	1 kg plywood, will be further processed into a plywood box at Nefab Emballage AB in Alfta, Sweden. The plywood boxes will be used for transportation of SKF spherical roller bearings.
Process Type	Gate to gate
Site	Not relevant
Sector	Materials and components
Owner	Not relevant
Technical system description	This activity describes a process step included in the system ''Production of plywood boxes'', also available in the SPINE@CPM database. Plywood boxes are used to pack the coated and non-coated roller bearings from SKF, Göteborg, during the transportation to customers. The plywood boxes are manufactured by Nefab Emballage AB in Alfta, Sweden. This dataset describes the production of plywood. Nefab Emballage AB uses plywood (birchwood) from Russia, but LCA data is not available from their Russian suppliers. Instead we use data for Swedish plywood (pinewood). Source: EPD (9709077, Trätek Sweden, 1997) of wooden based board, 7 mm pinewood, produced by Edsbyn Träförädling AB. Inventory figures given in g/kg dry board, starting from extraction of resources and ending at the gate of the company. Moisture quotient, 9% = [Mass,wet-Mass,dry]/Mass,dry; => Mass change factor = 1,09; Using input flow (Mass,dry) for the calculations. Data is taken from an earlier LCA study made at Packforsk consulting AB: Weström Pär, Packforsk Consulting AB; Simplified life cycle assessment for the comparison of two packaging alternatives for medium-sized roller bearings; Report no. C00 528; April 2001.

System Boundaries	
Nature Boundary	The glue used for the plywwod production is approximated as crude oil. Data is taken from an earlier LCA study made at Packforsk Consulting AB: Weström Pär, Packforsk Consulting AB; Simplified life cycle assessment for the comparison of two packaging alternatives for medium-sized roller bearings; Report no. C00 528; April 2001. For further information we refer to this LCA.
Time Boundary	The EPD from where the data is taken by Packforsk Consulting AB is written 1997.
Geographical Boundary	The plywood production takes place in Edsbyn, Sweden.
Other Boundaries	The production of diesel, LPG and electricity is NOT included in this dataset and must be taken into account in order to calculate the total environmental impact.
Allocations	Allocations have been made according to weight.
Systems Expansions	Not Applicable

Flow Data	
General Activity QMetaData	
Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed

Represents	Representing Swedish average
Method	Data is taken from an earlier LCA study made at Packforsk Consulting AB: Weström Pär, Packforsk Consulting AB; Simplified life cycle assessment for the comparison of two packaging alternatives for medium-sized roller bearings; Report no. C00 528; April 2001. For further information we refer to this LCA.
Literature Reference	Environmental Product Declaration from Trätek, Sweden –9709077; 1997. Weström Pär, Packforsk Consulting AB; Simplified life cycle assessment for the comparison of two packaging alternatives for medium-sized roller bearings; Report no. C00 528; April 2001.
Notes	The data is summarized by Thomas Björklund and Ann-Marie Tillman (Technical Environmental Planning, CTH, 412 96 Göteborg, Sweden) during the spring 1997 in LCA of Building Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Report 1997:2, but the sources are probably a few years older.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Crude oil	32.96			g	Technosphere	
	Input	Refined resource	Diesel	0.659			MJ	Technosphere	
	Input	Refined resource	Electricity	4.066			MJ	Technosphere	
	Input	Refined resource	Liquefied petroleum gas	1.033			MJ	Technosphere	
	Input	Refined resource	Oil	1.0989			MJ	Technosphere	
	Input	Refined resource	Renewable fuel	8.7912			MJ	Technosphere	
	Input	Refined resource	Wood	1428.5714			g	Technosphere	
	Output	Emission	Aliphatic HC	0.03296			g	Air	
	Output	Emission	Ashes	61.538			g	Air	
	Output	Emission	BOD	1.0989			g	Water	
	Output	Emission	CO	12.088			g	Air	
	Output	Emission	CO2	128.57			g	Air	
	Output	Emission	COD	2.3077			g	Water	
Notes: Air	Output	Emission	Dust	1.3187			g	Air	
	Output	Emission	Hydrocarbons	1.978			g	Air	
	Output	Emission	N total	0.0329			g	Water	
	Output	Emission	NOx	2.307			g	Air	
Notes: (<0,01 g/kg)	Output	Emission	Phosphorus	0.011			g	Air	
	Output	Emission	SO2	1.538			g	Air	
Notes: Water	Output	Emission	Suspended solids	0.4725			g	Water	
Notes: (from wood)	Output	Emission	VOC	0.989			g	Air	
	Output	Product	Plywood	1			kg	Technosphere	
Notes: Waste	Output	Residue	Mining waste	2.198			g	Technosphere	
	Output	Residue	Solid	16.484			g	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. Both types of bearings are packed in a plywood box. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The dataset is applicable for plywood production with the same composition as in the EPD (9709077, Trätek Sweden, 1997) of wooden based board, 7 mm pinewood, produced by Edsbyn Träförädling AB.

About Data	Data is taken from an earlier LCA study made at Packforsk Consulting AB: Weström Pär, Packforsk Consulting AB; Simplified life cycle assessment for the comparison of two packaging alternatives for medium-sized roller bearings; Report no. C00 528; April 2001. For further information we refer to this LCA.
Notes	

SPINE LCI dataset: Poland, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Poland, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Poland
Sector	Energyware
Owner	Poland
Technical system description	The generation of electricity with different power generating systems in Poland during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	Representing Swedish average
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	1890			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	2310			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	345			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	4			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	56102			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	592			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	79528			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	140771			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998

	Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Polyether-polyols - PUR precursors

Administrative	
Finished	Y
Date Completed	1996
Copyright	
Availability	

Technical System	
Name	Polyether-polyols - PUR precursors
Functional Unit	1 kg of polyether / polyols
Functional Unit Explanation	
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	This set of data concerns the production of the polyurethane precursors (TDI, MDI, Polyols) and not the production of the polyurethane foam. The principal raw materials for polyurethane precursors are crude oil and natural gas. The diisocyantes having the greatest commercial importance originate from the aromatic content (benzene and toluene), while the polyols come almost exclusively from the aliphatic content. Diisocyanates are obtained by phosphogenation of daimines which are produced, via a number of intermediates steps, from aromatic hydrocarbons. The diisocyanate with the greatest technical importance are tolyene diisocyanante (TDI) and diphenylmethane diisocyanate (MDI).

	The polyols used in polyurethane production are predominantly hydroxy-polyesters. They are produced by alkoxylation. Depending on the degree of cross-linking required, the starting alcohols used for hydroxy-polyethers may be divalent glycols (ethylene, propylene and other glycols) or multivalent alcohols. The epoxides used are generally propylene oxide and ethylene oxide.

System Boundaries

Nature Boundary	Air-, water- emissions out of our system Resource arriving into our system
Time Boundary	
Geographical Boundary	Europe
Other Boundaries	
Allocations	Unspecified
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	98/01/26
Data Type	Unspecified
Represents	Representing Swedish average
Method	Normal LCI method for the production of TDI (from the cradle to the gate)
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Bauxite	350			mg	Technosphere	Europe
	Input	Refined resource	Coal	10			MJ	Technosphere	Europe
	Input	Refined resource	Electricity	17			MJ	Technosphere	Europe
	Input	Refined resource	Heavy oil	30			MJ	Technosphere	Europe
	Input	Refined resource	Iron ore	2100			mg	Technosphere	Europe
	Input	Refined resource	Limestone	600000			mg	Technosphere	Europe
	Input	Refined resource	NaCl	1660000			mg	Technosphere	Europe
	Input	Refined resource	Natural gas	31			MJ	Technosphere	Europe
	Input	Refined resource	Natural sand	2200			mg	Technosphere	Europe
	Input	Refined resource	SO2	18400			mg	Technosphere	Europe
	Input	Refined resource	Water	156000000			mg	Technosphere	Europe
	Output	Emission	BOD	2000			mg	Water	Europe
	Output	Emission	CO	1500			mg	Air	Europe
	Output	Emission	CO2	3400000			mg	Air	Europe
	Output	Emission	COD	12100			mg	Water	Europe
	Output	Emission	H2	570			mg	Air	Europe
	Output	Emission	H2S	5			mg	Air	Europe
	Output	Emission	H2SO4	160			mg	Water	Europe
	Output	Emission	HC	11300			mg	Air	Europe
	Output	Emission	HC	1400			mg	Water	Europe
	Output	Emission	HCl	150			mg	Air	Europe
	Output	Emission	HF	3			mg	Air	Europe
	Output	Emission	Metals	131000			mg	Water	Europe
	Output	Emission	Metals	5			mg	Air	Europe
	Output	Emission	NOx	17900			mg	Air	Europe
	Output	Emission	N-tot	6100			mg	Water	Europe
	Output	Emission	Oil	60			mg	Water	Europe
	Output	Emission	Organic compounds	1100			mg	Water	Europe
	Output	Emission	Particles	7000			mg	Air	Europe
	Output	Emission	Phenol	2			mg	Water	Europe
	Output	Emission	P-tot	1400			mg	Water	Europe

	Output	Emission	SOx	15000			mg	Air	Europe
	Output	Emission	Sulphates	4300			mg	Water	Europe
	Output	Emission	Susp solids	70000			mg	Water	Europe
	Output	Product	Polyether - polyols	1			kg	Technosphere	Europe
	Output	Residue	Ashes	22000			mg	Technosphere	Europe
	Output	Residue	Industrial waste	89000			mg	Technosphere	Europe
	Output	Residue	Mineral waste	787000			mg	Technosphere	Europe

About Inventory	
Publication	Eco profiles ot the European plastics industry Report 9 : Polyurethane precursors (TDI, MDI, Polyols) APME technical report June 1996 -- Data documented by: Sophie Louis, Volvo Technical Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	APME's eco-profiles serve two
General Purpose	There is an increasing demand concerning LCA data. Following this trend, ISOPA [The European Isocyanate Producers Association] members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of polyther/polyols
Commissioner	- ISOPA, Avenue E. van Nieuwenhuyse 4 Box 2 B 1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	Data on the production processes have been supplied by ARCO Chemical, BASF, BAYER, DOW, Enichem, ICI, Rhone Poulenc and Shell relating to plants operating in Belgium, France Germany, Italy, the Netherlands, Portugal, Spain and the United Kingdom.
About Data	The transport of the different precursors to the plant where is produced polyurethane foam is not included here in this set of data. Data have been obtained from plants producing some 590000 tonnes of polyether-polyols in 1990. It is important to recognise that the data do not refer only to the final conversions stages leading to polyether-polyols but to all operations starting with raw materials in the earth.
Notes	

SPINE LCI dataset: Polyethylene

Administrative	
Finished	Y
Date Completed	1993
Copyright	
Availability	

Technical System	
Name	Polyethylene
Functional Unit	1 kg of polyethylene
Functional Unit Explanation	In the calculations, additives such as anti oxydants, dyes and fillers were excluded, as was all the outer packaging for the final product. However, the calculations do include the conversion of the polymer resin into grannules.
Process Type	Cradle to gate

Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	Polyethylene is chemically one of the simplest polymers. Essentially, it is formed by opening the double bond in neighbouring ethylene monomer molecules and linking them together. The polyethylenes available commercially can be divided into three main groups : low density polyethylene, high density polyethyene and linear low density polyethylene. Low density polyethylene is produced in a high presure process and contains a high level of side branching with long side branches. High density polyethylene is produced in a low pressure process and contains fewer side branches. Linear low density polyethylene contains a large number of side branches, but these are very short so the polymer is able to pack well in the solid state.

System Boundaries

Nature Boundary	Resource entering our system Emissions to air and water,and waste emitted outside our system
Time Boundary	
Geographical Boundary	Europe
Other Boundaries	
Allocations	Not detailed in the rapport APME / PWMI
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	98/01/26
Data Type	Unspecified
Represents	Representing Swedish average
Method	An LCI operation on the production of 1 kg of polyethylene (from the cradle to the gate)
Literature Reference	Eco-profiles of the European plastics industry Report 3 : polyethylene and polypropylene [May 1993] Association of Plastics Manufacturers in Europe Brussels - tel : +32 2 672 82 59 European Centre for Plastics in the Environment Brussels - tel : +32 2 675 32 58
Notes	

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Bauxite	300			mg	Technosphere	Europe
	Input	Refined resource	Electricity	7.89			MJ	Technosphere	Europe
	Input	Refined resource	Ferromanganese	0			mg	Technosphere	Europe
	Input	Refined resource	Heavy oil	35.34			MJ	Technosphere	Europe
	Input	Refined resource	Iron ore	200			mg	Technosphere	Europe
	Input	Refined resource	Limestone	150			mg	Technosphere	Europe
	Input	Refined resource	NaCl	7000			mg	Technosphere	Europe
	Input	Refined resource	Other fuel	42.6			MJ	Technosphere	Europe
Notes: In the report denoted as Clay	Input	Refined resource	Soil and loose earth material	20			mg	Technosphere	Europe
	Input	Refined resource	Water	18000000			mg	Technosphere	Europe
	Output	Emission	Acidification eq	70			mg	Water	Europe
	Output	Emission	Aldehydes	5			mg	Air	Europe
	Output	Emission	BOD	150			mg	Water	Europe
	Output	Emission	Chloride	120			mg	Water	Europe
	Output	Emission	CO	800			mg	Air	Europe

	Output	Emission	CO2	1100000			mg	Air	Europe
	Output	Emission	COD	1000			mg	Water	Europe
	Output	Emission	Dissolved organics	20			mg	Water	Europe
	Output	Emission	Dissolved solids	400			mg	Water	Europe
	Output	Emission	H2	1			mg	Air	Europe
	Output	Emission	HC	100			mg	Water	Europe
	Output	Emission	HC	21000			mg	Air	Europe
	Output	Emission	HCl	60			mg	Air	Europe
	Output	Emission	HF	1			mg	Air	Europe
	Output	Emission	Metals	1			mg	Air	Europe
	Output	Emission	Metals	300			mg	Water	Europe
	Output	Emission	NH3	5			mg	Water	Europe
	Output	Emission	NOx	11000			mg	Air	Europe
Notes: Denoted Other nitrogen in the report	Output	Emission	N-tot	10			mg	Water	Europe
	Output	Emission	Oil	100			mg	Water	Europe
	Output	Emission	Organic compounds	5			mg	Air	Europe
	Output	Emission	Particles	2000			mg	Air	Europe
	Output	Emission	Phenol	1			mg	Water	Europe
	Output	Emission	P-tot	5			mg	Water	Europe
	Output	Emission	SOx	7000			mg	Air	Europe
	Output	Emission	Sulphates	10			mg	Water	Europe
	Output	Emission	Susp solids	400			mg	Water	Europe
	Output	Product	PE	1			kg	Technosphere	Europe
	Output	Residue	Ashes	7000			mg	Technosphere	Europe
	Output	Residue	Industrial waste	3100			mg	Technosphere	Europe
	Output	Residue	Mineral waste	22000			mg	Technosphere	Europe
	Output	Residue	Non-toxic chemicals	2000			mg	Technosphere	Europe
	Output	Residue	Toxic chemicals	70			mg	Technosphere	Europe

About Inventory

Publication	Eco-profiles of the European plastics industry Report 3 : polyethylene and polypropylene [May 1993] Association of Plastics Manufacturers in Europe Brussels - tel : +32 2 672 82 59 European Centre for Plastics in the Environment Brussels - tel : +32 2 675 32 58 -- Data documented by: Sophie Louis, Volvo Technical Development Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	APME's eco-profiles serve two
General Purpose	There is an increasing demand concerning LCA data. Following this trend, APME [Association of Pastic Manufacturers in Europe] members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of polyethylene
Commissioner	- PWMI, European Centre for Plastics in the Environment Avenue E. Van Nieuwenhuyse 4 Box 5 B-1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	These data are available for polyethylene all grades. It means they are an average value of different types of polyethylene, which are following : LDPE, LLDPE and HDPE.
About Data	Data concerning inputs of energy and raw materials as well as air, water and solid waste emissions have been obtained from a total of 36 European ethylene polymeriastion plants producing 4,5 million tonnes of polyethylene of all grades. Of these, 10 plants produced 1,3 million tonnes of high density polymer, 22 plants produced 2,8 million tonnes of low density polymer and the remaining four plants were responsible for the production of 359 000 tonnes of linear low density polymer.
Notes	

SPINE LCI dataset: Polymerization in LDPE production process. ESA-DBP

Administrative	
Finished	Y
Date Completed	2009
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Polymerization in LDPE production process. ESA-DBP
Functional Unit	1 kg of LDPE (low density polyethylene)
Functional Unit Explanation	
Process Type	Other
Site	Borealis, Sweden
Sector	Manufacturing
Owner	Borealis, Sweden
Technical system description	Polymerization discussed in this study is a one of the steps in crude oil based LDPE (low density polyethylene) production process. This process is gate-to-gate but the electricity and fuel are traced back to the cradle. In this step ethylene is processed into LDPE. Data are valid for Sweden but for electricity calculations average European data were used. Excerpt from the report, see 'Publication': ''Low density polyethylene (LDPE) is produced under high pressures (81-276MPa) and temperatures (130-330ºC) in either a tubular or stirring autoclave reactor. The products from this two reactor types differ mainly in their long chain branching composition due to differences in their backmixing. The result is shorter long-chain branching in stirring autoclave reactors, and longer in the tubular reactor. The mechanism leading to the formation of the branched polymer is chain growth polymerization. It includes four reaction steps: initiation, propagation, branching and termination. The initiation starts with the decomposition of an initiator material, usually peroxides. When exposed to heat or irradiation, the peroxides, decompose releasing a free radical, which attacks the ethylene and starts the growth of the radical chain. In the next step, the propagation, an olefin radical chain attacks the double bonds of the surrounding ethylene monomers causing an addition reaction to occur and results in a longer chain. In the process, the active center moves to the end of the new, longer chain and continues adding more monomers. The chain grows. However, the radical chain does not only react with double bonds in the monomers, but also with hydrogen from another polymer chain. The result is the termination of the first chain and a movement of the active center to the middle of the second chain, which now grows from there. This process is the called branching. The termination of the chain growth can be caused by different reactions. The two most important termination reactions are coupling and disproportionation. Coupling is the reaction of two polymer chains resulting in the formation of a long polymer molecule. Disproportionation is the transfer of a labile atom from one radical to another leading to two inert polymer chains. A third termination mechanism is chain transfer. It involves the transfer of the active center of a polymer chain to a monomer or to a solvent, added to the mix to terminate the chain growth. In dependence of the reactivity of the newly formed radical, it might initiate the formation of a new polymer chain. After the polymerization, the product stream passes through different separation steps to recover the not reacted ethylene gas for recycling and to remove waxes. The cleaned, molten polymer is then mixed with stabilizers and additives and finally made into pellets. In this last step, the polymer is forced through an extruder head to from the required shape and size of pellets. The pellets are usually cut under water and dried in a centrifugal drier.'' This process is included in the system described in: Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2009--14.pdf

	Other processes in the CPM Database also included in the above publication: - Ethylene production from cane based ethanol. ESA-DBP - Sugarcane cultivation. ESA-DBP - Refinery in crude oil based LDPE production process. ESA-DBP - Steam cracking in crude oil based LDPE production process. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''Outputs accounted for in this study were by-products and emissions released to air. Water emissions were omitted, because of data unavailability for some parts of the sugarcane route.'' The data relate also to the fuel and electricity consumption which were traced back to the cradle.
Time Boundary	Data for steam cracking come from 2008 and they were acquired as the most up-to-date ones.
Geographical Boundary	Process data are valid for Sweden. For electricity calculations the average data from Europe were applied.
Other Boundaries	Excerpt from the report, see 'Publication': ''- total input treated as ethylene - production mix does not change with input composition - conversion rate does not change with input composition - external fuel treated like diesel to account environmental impact''
Allocations	No allocation needed.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2008
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''Process data for the polymerization originated from Borealis, Sweden (2008). The electricity consumed, was assessed under marginal and average electricity supply - see section electricity consumption The environmental impact of external fuels consumed at the production site (consumption data according to Borealis (2008)) were assessed according emissions data from SPINE LCI (2008). External fuels were treated like diesel under the assumption that diesel and fuel oil have the same environmental impact during their production.
Literature Reference	Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2009--14.pdf
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	1.34E+01			MJ	Technosphere	Sweden
	Input	Refined resource	Ethylene	1.00E+03			g	Technosphere	Sweden
	Input	Refined resource	Fuel	3.00E-01			MJ	Technosphere	Sweden
	Output	Emission	CH4	1.20E+00			g	Air	Sweden
	Output	Emission	CO	3.00E-01			g	Air	Sweden
	Output	Emission	CO2	6.80E+02			g	Air	Sweden
	Output	Emission	HC	1.80E-03			g	Air	Sweden
	Output	Emission	HFC	1.00E-01			g	Air	Sweden
	Output	Emission	N2O	1.60E-02			g	Air	Sweden
	Output	Emission	NMVOC	2.00E-02			g	Air	Sweden
	Output	Emission	NOx	1.20E+00			g	Air	Sweden
	Output	Emission	SO2	3.70E+00			g	Air	Sweden
	Output	Emission	VOC	1.90E+00			g	Air	Sweden
	Output	Product	LDPE	1.00E+03			g	Technosphere	Sweden

About Inventory

Publication	Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2009--14.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this study is to answer the question, is the use of sugarcane based LDPE in the production of goods and packing in Sweden environmentally preferable to crude oil based LDPE.''
Detailed Purpose	Polymerization is a step in the production process of LDPE so it was necessary to investigate the environmental load of it.
Commissioner	Unknown - .
Practitioner	Christin Liptow & Anne-Marie Tillman - Environmental Systems Analysis, Chalmers University of Technology.
Reviewer	Tillman, Anne-Marie - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Polymerization is a step in a production process of oil based LDPE which was the object of the study. The production process starts with crude oil extraction and is followed by refinery, steam cracking, polymerization, use phase (which was excluded from the study) and inceneration as the end of life. Oil based- was compared in the study to the sugarcane based- LDPE. NB: in the report two approaches were investigated: attributional and consequential. For consequential approach see the report.

SPINE LCI dataset: Polypropylene

Administrative	
Finished	Y
Date Completed	1993
Copyright	
Availability	

Technical System	
Name	Polypropylene
Functional Unit	1 kg polypropylene
Functional Unit Explanation	
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	

Technical system description	Polypropylene is chemically similar to polyethylene. It is produced from propylene (propene) monomer. The polymerisation mechanism is similar to that for polyethylene ; the double bond on adjacent molecules is opened and the molecules combine to produce a polystructure. This structure is similar to polyethylene except that alternate carbon atoms are attached to a CH3 group rather than a hydrgen atom.

System Boundaries

Nature Boundary	Air-, water-emissions and waste going out of our system Resource, input to our system
Time Boundary	
Geographical Boundary	Europe
Other Boundaries	
Allocations	Unspecified
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	98/01/26
Data Type	Unspecified
Represents	See 'Function'
Method	Normal LCI method on the considered process (from the cradle to the gate)
Literature Reference	Eco-profiles of the European plastics industry Report Nr. 3 : Polyethylene and propylene (May 1993) Association of Plastics Manufacturers in Europe Brussels - tel : +32 2 672 82 59 European Center for Plastics in the Environment Brussels - tel : +32 2 675 40 02
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Bauxite	400			mg	Technosphere	Europe
	Input	Refined resource	Electricity	6.85			MJ	Technosphere	Europe
	Input	Refined resource	Ferromanganese	0		1	mg	Technosphere	Europe
	Input	Refined resource	Heavy oil	52.65			MJ	Technosphere	Europe
	Input	Refined resource	Iron ore	300			mg	Technosphere	Europe
	Input	Refined resource	Limestone	200			mg	Technosphere	Europe
	Input	Refined resource	NaCl	5000			mg	Technosphere	Europe
	Input	Refined resource	Other fuel	20.53			MJ	Technosphere	Europe
Notes: Denoted as Clay in the report	Input	Refined resource	Soil and loose earth material	30			mg	Technosphere	Europe
	Input	Refined resource	Water	3100000			mg	Technosphere	Europe
	Output	Emission	Acidification eq	90			mg	Water	Europe
	Output	Emission	BOD	60			mg	Water	Europe
	Output	Emission	Chloride	800			mg	Water	Europe
	Output	Emission	CO	700			mg	Air	Europe
	Output	Emission	CO2	1100000			mg	Air	Europe
	Output	Emission	COD	400			mg	Water	Europe
	Output	Emission	Dissolved organics	30			mg	Water	Europe
	Output	Emission	Dissolved solids	200			mg	Water	Europe
	Output	Emission	H2S	10			mg	Air	Europe
	Output	Emission	HC	13000			mg	Air	Europe
	Output	Emission	HC	300			mg	Water	Europe
	Output	Emission	HCl	40			mg	Air	Europe
	Output	Emission	HF	1			mg	Air	Europe

	Output	Emission	Metals	300			mg	Water	Europe
	Output	Emission	Metals	5			mg	Air	Europe
	Output	Emission	NH3	10			mg	Water	Europe
	Output	Emission	NOx	10000			mg	Air	Europe
Notes: Denotes as Other nitrogen in the report	Output	Emission	N-tot	10			mg	Water	Europe
	Output	Emission	N-tot	20			mg	Water	Europe
	Output	Emission	Oil	40			mg	Water	Europe
Notes: Denoted as Other organics in the report	Output	Emission	Organic compounds	250			mg	Water	Europe
	Output	Emission	Particles	2000			mg	Air	Europe
	Output	Emission	P-tot	20			mg	Water	Europe
	Output	Emission	SOx	11000			mg	Air	Europe
	Output	Emission	Susp solids	200			mg	Water	Europe
	Output	Product	PP	1			kg	Technosphere	Europe
	Output	Residue	Ashes	5000			mg	Technosphere	Europe
	Output	Residue	Industrial waste	4000			mg	Technosphere	Europe
	Output	Residue	Mineral waste	14000			mg	Technosphere	Europe
	Output	Residue	Non-toxic chemicals	8000			mg	Technosphere	Europe
	Output	Residue	Toxic chemicals	30			mg	Technosphere	Europe

About Inventory	
Publication	Eco profiles of the European plastics industry Report 3 : Polyethylene and polypropylene May 1993 -- Data documented by: Sophie Louis, Volvo Technical Development Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	APME's eco-profiles serve two
General Purpose	There is an increasing demand concerning LCA data. Following this trend, APME members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of polypropylene
Commissioner	- PWMI, European Centre for Plastics in the Environment Avenue E. Van Nieuwenhuyse 4 Box 5 B-1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	In the calculations, additives such as anti oxydants, dyes and fillers were excluded, as was all the outer packaging for the final product. However, the calculations do include the conversion of the polymer resin into granules.
About Data	Data on the production of polypropylene have been obtained from 14 polymerisation plants producing a total of 1,5 million tonnes.
Notes	

SPINE LCI dataset: Portugal, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System

Name	Portugal, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Portugal
Sector	Energyware
Owner	Portugal
Technical system description	The generation of electricity with different power generating systems in Portugal during the year 1998. Portugal includes the Azores and Madeira.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	1			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	1023			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	10687			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	12055			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	12983			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	2018			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	58			GWh	Technosphere	

Represents: Wind	Input	Refined resource	Electricity	89			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	38914			GWh	Technosphere	

About Inventory	
Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998

About Data	
Notes	

SPINE LCI dataset: Potentiometer assembly

Administrative	
Finished	Y
Date Completed	2000-02-22
Copyright	Ericsson
Availability	Official

Technical System	
Name	Potentiometer assembly
Functional Unit	One gram potentiometer
Functional Unit Explanation	The motivation for choosing this functional unit is: · suitable unit to work with in an LCA of a private branch exchange (a complicated telecom product) · important component of the MD110 product system and many other electronic products. DESIGN These facts are based on Ericsson technical specification of the component. Ericsson product number: REL 320 0225/1 Ericsson description: Potentiometer General technical specification Single sliding potentiometer for hole mounting. The potentiometer is designed for both AC and DC applications. The lever is nonconductive. Weight: about 2.7 grams Terminal diameter: 0.7 - 1.3 mm Terminal length: 0.4 mm Height: 6.5 - 7.5 mm Length: 29.5 - 30.5 mm Width: 7.5 - 8.5 mm
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of a potentiometer. The activity is based on information acquired from one manufacturer. The description of the process is assumed to be general for this type of manufacture. The following process steps are included; Typical steps are: 1. Printing 2. Curing 3. Punching 4 Terminal revetting 5. Molding 6. Assembling 7. Function test 8. Packaging 9. Final inspection Details given:

	1. Printing: Silver/carbon paste for conductive/resistive pattern is printed on a phenolic laminated substrate. 2. Curing: The paste is dried and cured. 3. Punching: Resistive element is punched out from the substrate. 4 Terminal revetting: metal terminals are riveted and attached to the resistive element. 5. Molding: plastic housing is formed around the resistive element. 6. Assembling: All parts are assembled.

System Boundaries

Nature Boundary	The emissons to air and water have nature as recipient. Each parameter mentioned by the component manufacturers have been studied. No parameter has deliberately been disregarded when environmental impact have been studied.
Time Boundary	1997 The answer from the manufacturer arrived in 1998 and they measured in 1997. The process technology used is most certainly the best available as the factory is located in Japan and the company is well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturer included in the average is located in Japan.
Other Boundaries	Delimitations to the system is the final step in the making of the potentiometer. The production of the subparts (e.g. galvanized sheet and phenolic laminated sheet) of the potentiometer is not included in this model. The transportation of them to the factory is not included. For interested parties who which wish to include the transport figures given from the manufacturer, can find the figures in the section Applicability.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1999
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The data that are presented are calculated based on information from one component manufacturer. The information from the manufacturer was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers In the information supplied by the potentiometer manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+..+.ACn Step 2: The sum AC11+..+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.)
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 5,1/2717,1 = 0,00188 g/g	Input	Refined resource	Acetone	0.0019			g	Technosphere	

Date concieved: 1997 Data type: Derived, unspecified Method: CM: 1.7 mg/2717.1 mg = 6.3e-4 g/g Notes: Recycling: 0.6 mg/2717.1 mg = 2.2e-4 g/g	Input	Refined resource	Ag	0.00063			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 21,2 Wh / 2,717 g = 7,8 Wh/g potentiometer	Input	Refined resource	Electricity	7.8			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 11/2717,1 = 0,00405 g/g	Input	Refined resource	Methanol	0.0041			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 250 mg/2717.1 mg = 0.092 g/g Notes: Recycling: 214 mg/2717.1 mg = 0.079 g/g	Input	Refined resource	Nickel silver	0.092			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0,43 ml used, i.e. 0,43 cm3 0,8 g/cm3 HHV Oil, 45 MJ/kg. according to Brohammer, Produktekologi, (ISBN 91-7548-544-3), page 116. 0,43*0,8/1000*45 = 0,01548 MJ 0,01548 MJ/2,717 g = 0,0057 MJ/g	Input	Refined resource	Oil	0.0057			MJ	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 2300 mg/2717.1 mg = 0.85 g/g Notes: Recycling: 2070 mg/2717.1 mg = 0.76 g/g	Input	Refined resource	Phenolic laminated sheet	0.85			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 220 mg/2717.1 mg = 0.081 g/g Notes: Recycling: 170 mg/2717.1 mg = 0.63 g/g	Input	Refined resource	Phosphorous bronze	0.081			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 1500 mg/2717.1 mg = 0.55 g/g	Input	Refined resource	Poly(butylene terephthalate)	0.55			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 1700 mg/2717.1 mg = 0.62 g/g	Input	Refined resource	Polyacetal	0.62			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 5180 mg/2717.1 mg = 1.91 g/g	Input	Refined resource	Steel	1.91			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 5,1/2717,1 = 0,00188 g/g Literature: The answer itself. Notes: None.	Output	Emission	Acetone	0.0019			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 11/2717,1 = 0,00405 g/g	Output	Emission	Methanol	0.0041			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 155420/2717,1 = 57,2 g/g	Output	Emission	Water	57			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: 1 gram potentiometer output is the base for all figures in this model. Potentiometers = Life Cycle Inventory model for production of one gram of potentiometer (applicable to telecommunication equipment)	Output	Product	Potentiometers	1			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 120 mg/2717.1 mg = 0.044 g/g Notes: Recycling: 1090 mg/2717.1	Output	Residue	Poly(butylene terephthalate)	0.044			g	Technosphere	

mg = 0.40 g/g									
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 136 mg/2717.1 mg = 0.05 g/g Notes: Recycling: 1224 mg/2717.1 mg = 0.45 g/g	Output	Residue	Polyacetal	0.05			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 1020 mg/2717.1 mg = 0.375 g/g Notes: Recycling: 2390 mg/2717.1 mg = 0.88 g/g	Output	Residue	Steel	0.38			g	Technosphere	

About Inventory

Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a potentiometer manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of potentiometers and resembling components in our telecom products. The usage for this set of data are life cycle assessments where potentiometers are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly

	4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to potentiometers in electronic equipment if you know how much the potentiometers weigh. -- Transports.-- Here follows a more detailed description of transports of materials and components to the manufacturer factory. These transports are not included in the model. The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport. -- Truck transportation: -- Component manufacturer: Weight of component: 2.7171 g Galvanized sheet with weight 3.8 g is transported 500 km by road i.e. 3.8 g*500 km, Polyacetal 1.7 g*400 km, Polybutylene terphtalate 1.5 g*850 km, Carbon Steel 1.4 g*50 km and Phenolic laminated sheet 2.3 g*1200 km. The total transportation work is calculated as follows: The sum weight of the products materials and components given from material mass multiplied by distance divided by the weight of the component. This gives: 6685 gkm/2.7171 g = 2460.34 gkm/g -- Boat transportation: -- Carbon steel with weight 1.4 g is transported 1200 km by boat i.e. 1.4 g*1200 km. 1680 gkm/2.7171 g = 618.31 gkm/g
About Data	The data is based on information from one Japanese manufacturer. The information was gathered using a life cycle inventory questionnaire. The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. 18 % of the flows stated by CM have been just estimated. 41 % of the flows stated have first been estimated and the calculated and 41 % of the flows stated have been just calculated. The outline of the LCI data questionnaire that was used in the inventory follows below. No

	limitations or specifications were set for which substances they had to account. -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes.´ Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gatherd it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Preparation and anti-corrosive treatment of construction steel

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Preparation and anti-corrosive treatment of construction steel
Functional Unit	ton
Functional Unit Explanation	1 ton blasted and/or painted construction steel

Process Type	Gate to gate
Site	TIBNOR AB, GÖTEBORG Box 484 40127 Göteborg Sweden
Sector	Materials and components
Owner	TIBNOR AB, GÖTEBORG Box 484 40127 Göteborg Sweden
Technical system description	The company prosecute wholesales business, with a distribution stoorage. At the storage there is a painting plant, for construction steel, where preparation and anti-corrosive treatment is done. The treatment consist of blasting, priming and painting. Blasting and priming The painting plant consist of a prewarming zone, sling-cleaning machine, painting box and a drying tunnel. The goods are brought through the plant by a conveyor belt. In the sling-cleaning machine the goods are blasted with steel bullets. In this process dust containing metal is formed. The outgoing air is filtered by a locking filter of patron type. Two component epoxi/polyvinylbutyral shopprimer and thinner are used for painting. The solvents consist mainly of acetone, toluene and isopropyl alcohol. When using shopprimer and thinner organic solvents are emitted to the air. To limit the emission the painting plant is equiped with a thermal combustion plant. Air from the painting box and the drying tunnel is led to the combustion chamber, where the hydrocarbon is combusted at a temperature of 800 deg C. Cleansed heated air is used to heat the goods before the sling-cleaning and the painting. After the air has been heated it is led out through a heat exchanger above the roof. The smoke-stack ends 16 m above ground and 3 m above the roof.´Heat from the heat exchanger is used to raise the temperature in the drying tunnel. No process water arises and no abnormal surface water polution occur. Stored goods are not oil treated and oil is not used in the treatment of the material.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	See 'Function'
Method	Studying the environmental report. The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1996.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1996 Data type: Unspecified Notes: Shell antifreeze 402 (monoethylenglykole, borax, natriumbensoat, sodiumnitrite, Sodiumnitrate, Tolyltriazol) Used as antifreeze in trucks etc.	Input	Refined resource	Antifreezers	0.036049027			l	Technosphere	
Notes: Product name: Formula 400(modified dicarboxyle acid diethyl alcoholamide, polycarboxyl acidaminesalt, bensotriazol, condenced boron acid-	Input	Refined resource	Cutting fluid	0.072098053			l	Technosphere	

alkanolamine, polyethylenglykole) Used as skärvätska when sawing.									
Notes: The oil type is Eo1 MK3	Input	Refined resource	Fuel oil	0.001568133			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified	Input	Refined resource	Liquefied petroleum gas	0.014203317			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Hydraulic oil, which has the product name Thellus (alifatic hydrocarbon mixture, highly refined mineral oil and function enbettering additives) Is used for trucks and machines.	Input	Refined resource	Lubricating oil	0.036049027			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Production name: Teknos, consisting of toluene, epoxiharts, methylethylketone, isopropyl alcohol, polyamine, ethyl alcohol, xylene, butanol, Alifatisk The substance is used for anti-corrosive treatment	Input	Refined resource	Shopprimer	5.082912761			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Untreated construction steel	Input	Refined resource	Steel	1			tonne	Technosphere	
Notes: 85,1% Teknos 9506 (xylene, aromatic hydrocarbon, isobutanol, propylenglykolmethylether), 14,9% Teknos 9514 (toulene, isopropyl alcohol, ethylmethylketone. The substance is used for anti-corrosive treatment	Input	Refined resource	Thinner	0.483056957			l	Technosphere	
Date concieved: 1996 Data type: Calculated Method: The value has been calculated, given the power of cleaning (99,7%). The power of cleaning has been measured at the time when the cleaning devise was installed, and then continiously at the annual inspection. Notes: Emission from Shopprimer and thinners.	Output	Emission	Solvents	0.0000108			tonne	Air	
	Output	Product	Blasted and painted construction steel	1			tonne	Technosphere	
Date concieved: 1996 Notes: Is taken care of by the local waste disposal company	Output	Residue	Combustible waste	0.0014015862			tonne	Technosphere	
Date concieved: 1996 Notes: Dust from blasting Is taken care of by the local waste disposal company	Output	Residue	Dust	0.00515991364			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Empty paint barrols The barrols are desposed by AB Anders Hillertz	Output	Residue	Empty barrels	0.009552992			pce	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: (Oil emulsion) The waste is desposed by Reci Industri AB	Output	Residue	Hazardous waste	0.100937275			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: 66,1% paint sludge, 17,1% paint/enamel waste, 16,7 spray booth waste. The waste is desposed by Reci Industri AB	Output	Residue	Hazardous waste	2.588680606			kg	Technosphere	
Date concieved: 1996 Notes: Is taken care of by the local waste disposal company	Output	Residue	Other rest products	0.00382062016			tonne	Technosphere	

About Inventory	
Publication	The environmental report from TIBNOR AB, GÖTEBORG for 1996, The Environmental Administration in the municipality of Göteborg. -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Persson Torbjörn, Andersson Henry - TIBNOR AB, GÖTEBORG Box 48440127 Göteborg Sweden.
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	
About Data	
Notes	

SPINE LCI dataset: Pre-stressing wire production

Administrative	
Finished	Y
Date Completed	1996-10-01
Copyright	
Availability	Public

Technical System	
Name	Pre-stressing wire production
Functional Unit	kg
Functional Unit Explanation	1 kg pre-stressing reinforcement wire
Process Type	Gate to gate
Site	Fundia Hjulsbro AB Box 344 581 03 Linköping Sweden
Sector	Materials and components
Owner	Fundia Hjulsbro AB Box 344 581 03 Linköping Sweden
Technical system description	Steel wire is the base for production of pre-stressing reinforcement wire. About 80% of the steel wire are taken from Fundia Wire Oy AB, a steelwork in Koverhar that is within the Fundia group. Some wire is also imported (about 20%), mainly from Germany and Belgium.

System Boundaries	
Nature Boundary	Emissions to air and water Emissions to air are not measured. Because of very small quantities, emissions to water (with the exception o suspended solids) are assumed as negligible and are omitted in the calculations.

Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	
Allocations	As pre-stressing wire is the main product at Fundia Hjulsbro (a small quantity of other steel products is also produced), all environmental load is allocated to this product. However, raw material use is allocated equally per mass unit to all products. Scrap (36.3 g/kg) is regarded as a low-grade product, and thus no environmental impact is allocated to the scrap. All scrap is sent to Fundia Special Bar in Smedjebacken by railway for recycling.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Unspecified
Represents	See 'Function'
Method	Literature study, personal communication
Literature Reference	Environmental report 1994, Fundia Hjulsbro AB, Linköping, 1995 Personal communication: Knutsson C., Fundia Hjulsbro AB, Linköping, 1995
Notes	The data type unspecified implies that one do not know how what the data is based on.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Additives	13.7			g	Technosphere	
	Input	Refined resource	Diesel-energy-precom	0.031			MJ	Technosphere	
	Input	Refined resource	Electricity	2.01			MJ	Technosphere	
	Input	Refined resource	Oil (eo1)	0.433			MJ	Technosphere	
Notes: The steel is ore-based.	Input	Refined resource	Reinforcement steel	1.04			kg	Technosphere	
	Output	Emission	Susp solids	0.00289			g	Water	
	Output	Product	Prestressing wire	1			kg	Technosphere	
	Output	Residue	Hazardous waste	0			g	Other	
	Output	Residue	Industrial waste	4.36			g	Other	

About Inventory

Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden -- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology --
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural concrete and steel frames in buildings during the whole life-cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of pre-stressing wire
Commissioner	- Finncement and Trätek (The Swedish Institute for Wood Technology Research) Box 5609 S-114 86 Stockholm Sweden.
Practitioner	Björklund T., Jönsson Å., Tillman A-M - Technical Environmental Planning, CTH Sven Hultins Gata 8 412 96 Göteborg Sweden .
Reviewer	
Applicability	To calculate the total environmental load for pre-stressing wire, including reinforcement steel production, you can use the data in this Database at:

	Name: Swedish reinforcement steel mix Category: Other Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden The function of the technical system is not sufficently described. Contact the company to get the necessary details.
About Data	Raw materials Chemicals, in the calculations regarded as a non-elementary flow, to 77% consist of sulphuric acid but also of lime, lubricant oils, surface treatment liquids etc. Waste By industrial waste is referred to metal hydroxide sludge with a high lime content, combustible and non-combustible waste. Hazardous waste mainly consists of sulphuric acid, originally accounted for as volume (a density of 1000 g/l is assumed).
Notes	

SPINE LCI dataset: Pre-treatment of biowaste

Administrative	
Finished	Y
Date Completed	2002-08-14
Copyright	
Availability	Public

Technical System	
Name	Pre-treatment of biowaste
Functional Unit	1 tonne of biowaste
Functional Unit Explanation	1 tonne of biowaste containing non-recyclable paper (15 weight-%) and organic material (85 weight-%).
Process Type	Gate to gate
Site	Europe
Sector	Waste treatment
Owner	Europe
Technical system description	Pre-treatment of biowaste has two basic functions: The sorting of the organic material from other fractions in the incoming waste, and the preparation of this biowaste material for the subsequent biological processing - composting or biogasification. The biological treatment processes are not included in this activity. The amount of pre-treatment will depend on the nature of the incoming waste - the more narrowly defined the incoming material, the less separation will be required. The biowaste is sorted into two fractions, one for biogasification and one for composting. Pre-sorting residue is also an output of the system to account for material that is not biodegradable. Sorting techniques used are manual sorting and mechanical sorting. Preparation steps included are size reduction, homogenisation and moisture control. Although there is no standard pre-treatment process, an energy consumption of 25 kWh per input tonne is provided in the model as a default value. Energy consumption depends on which operation and which input waste stream that is used. (McDougall, IWM, 2001) This activity is a part of the aggregated system, Solid waste management. Pre-treatment distributes one fraction of biowaste to Composting and one to Biogasification. Reference: McDougall F. et al, Integrated Solid Waste Management: a Life Cycle Inventory, Procter & Gamble Technical Centres, Black Science, 2001.

System Boundaries

Nature Boundary	No emissions to air, water or ground are included due to lack of data.
Time Boundary	1992-2001
Geographical Boundary	The aim is that this Pre-treatment activity represents European conditions.
Other Boundaries	
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1992-2001
Data Type	Unspecified
Represents	See 'Function'
Method	Data for electricity consumption was based on a study, Integrated Solid Waste Management performed by Forbes McDougall et al at Procter& Gamble Technical Centres, 2001. Data for the amount of biowaste to biogasification and biowaste to composting is based on assumptions performed by the person reponsible for the documentation.
Literature Reference	Integrated Solid Waste Management:a Life Cycle Inventory, Forbes McDougall et all, Procter & Gamble Technical Centres, 2001
Notes	The data type unspecified implies that one do not know how what the data is based on.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: See functional unit	Input	Refined resource	Biowaste	1			tonne	Technosphere	
Date concieved: 1992-2001 Method: An average energy consumtion for a sorting plant is 25 kWh/tonne input waste. (McDougall, IWM, 2001) Literature: Integrated Solid Waste Management:a Life Cycle Inventory, Forbes McDougall et al, Procter & Gamble Technical Centres, 2001	Input	Refined resource	Electricity	25			kWh	Technosphere	
Method: An assumption of 50% biowaste to composting was made by the person responsible for the documentation.	Output	Product	biowaste to biogasification	0.5			tonne	Technosphere	
Method: An assumption of 50% biowaste to biogasification was made by the person responsible for the documentation.	Output	Product	biowaste to composting	0.5			tonne	Technosphere	

About Inventory

Publication	McDougall F. et al, Integrated Solid Waste Management - A Life Cycle Inventory, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Data documented by: Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Documentation reviewed by: Ann-Christin Pålsson, Industrial Environmental Informatics, Chalmers University of Technology Published in SPINE@CPM: 14 August 2002
Intended User	The documentation of this syst
General Purpose	This activity was made to give an indication of pre-treatment of biowaste since data about waste management systems are insufficient and more data are required from the industry.
Detailed Purpose	The purpose of the documentation of this system has been to make data for Pre-treatment of biowaste, a part of Solid waste managment, available in this format for the industry. Data was put together by the person responsible for the documentation using the study Integrated Solid Waste Management F McDougall et al at Procter & Gamble Technical Centres, 2001 as a reference.

Commissioner	
Practitioner	
Reviewer	
Applicability	This activity can be used in the aggregated system of solid waste management only. The amount of waste to biogasification and composting depends on the availablity of biogasification plants. Biogasification is a more limited application but the number of facilities world-wide are increasing rapidly. In 2001 about 20-70% of biowaste produced can be treated in a biogasification plant, depending of the area. The type of pre-sorting installed affects the amount of secondary materials produced in a subsequent composting or biogasification plant depending on the composition of the input stream. A narrowly defined input, such as biowaste or vegetable/fruit and garden waste will contain a certain level of contamination; this material is not suitable for recovery.
About Data	Data in this activity is unspecified. Assumptions concerning pre-treatment of biowaste have been made by the person responsible for the documentation, e.g. 50% biowaste to composting. The descriptions of the activity is based on the study Integrated Solid Waste Management by F McDougall et al at Procter & Gamble Technical Centres, 2001. It is described how it was understood by the person who made the documentation.
Notes	For further information about solid waste managment see: Flemström K., Brief overview of solid waste management, IMI-internal report. The report may be downloaded from: http://www.imi.chalmers.se

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SPINE LCI dataset: Primary aluminium production

Administrative	
Finished	Y
Date Completed	2002-05-07
Copyright	EAA
Availability	Public

Technical System	
Name	Primary aluminium production
Functional Unit	1000 kg aluminium ingot
Functional Unit Explanation	The aluminium ingots are delivered as slabs, billets etc.
Process Type	Cradle to gate
Site	Not specified. See Geographical boundaries for further information.
Sector	Materials and components
Owner	Not specified. See Geographical boundaries for further information.
Technical system description	This system represents the production of primary aluminium that are sold on the European market. Some import of aluminium is included. About 40% of the primary aluminium used in Europe is imported (19% from Russia and 20% from the western world outside Europe, during the years 1990-1999). The production includes the following process steps: 1. Bauxite mining 2. Transport of bauxite to alumina production plant (7453 km) 3. Production of alumina (aluminium oxide) 4. Transport of alumina to electrolysis (3998 km) 5. Electrolysis 6. Casting Some of the process steps are described in more detail below.

	3. Production of alumina (aluminium oxide): -- 3.1. Production of NaOH (caustic soda) 3.2. Transport of NaOH to alumina production plant 3.3. Limestone mining, lime calcination 3.4. Transport of lime to alumina production plant 3.5. Production of alumina at the alumina production plant.The main raw material for alumina is bauxite, which is extracted from bauxite mines and processed into aluminium oxide at alumina production plants. 5. Electrolysis: -- 5.1. Anode production, including anode butt recycling and transport to Electrolysis 5.1.1 Petrol coke and filling material production and transport to Anode production 5.1.2 Pitch production and transport to Anode production 5.2. Cathode production and transport to Electrolysis 5.3 AlF3 production and transport to Electrolysis 5.4. Production of liquid aluminium metal at the Electrolysis This system represents the European average situation, which uses about 15% Söderberg technology (anode consists of söderberg paste) and 85% Prebake technology (newer and cleaner technology with solid anodes) in the electrolysis. 6. Casting: -- Input material to this activity is liquid metal (from the electrolysis), alloying metals, and fluxing agents. A basic cast house have been worked out, i.e. typically yielding primary aluminium ingot for rolling, extrusion or remelting. No data for the production of alloying metals and fluxing agents is included in this data set. ENERGY CONSUMPTION/PRODUCTION The electrolysis, also referred to as the smelter, is by far the most energy consuming process in primary aluminium production. The total consumption in this system consists of the following elements: - rectifying loss - DC power usage - pollution control equipment - auxillary power (general plant use) - net electric transmission losses of 2% have been taken into account from power stations to primary smelters, as all primary smeltershave their energy delivered by high voltage lines from power stations located nearby, and operate their own transformer facilities. Use of energy and fossil fuel for electricity production and related air emissions is also included, except for nuclear and hydroelectricity which only includes the energy consumption in the distribution net. A model for electricity production has been applied to this system, in accordance with the fact that about 40% of the primary aluminium used in Europe is imported (19% from Russia and 20% from the western world outside Europe, during the years 1990-1999). See headline Method under the section General QMetaData to get more details on the electricity production model.

System Boundaries

Nature Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- Cut-off criteria through out this inventory is basically relevance, as checked by the industry expert team monitoring the work and confirmed by reviewer I. Boustead. As a rough guideline ''less than 1% of total mass'' is applied for the inputs, i.e if the input is less than 1% of the total mass, then it is not included in the inventory table. The base for the choices of included inventory parameters is not further described in the EAA report.
Time Boundary	The data is collected between 1995 and 1998. Data for Bauxite mining is from 1991. Production of alumina (aluminium oxide): data for Limestone production from 1989-1994, data for Caustic soda production from 1999. Data for the electricity supply systems, the fuel production and use (energy carrier consumption, emissions) is from 1998.
Geographical Boundary	--- SPECIFIC BOUNDARIES FOR THIS DATA SET--- The aim of the study was to represent the European aluminium market, i.e. the environmental performance of aluminium products sold in Europe. The data is collected from European aluminum producers to provide LCA-practitioners with detailed and up-to-date information representing the aluminium industry activities in Europe. For the aluminium imported to Europe, the electricity production system in Russia and the west world have been regarded.

	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- It is not always explicit in the report where the different included process steps take place. Data may be acquired from outside of Europe, e.g. regarding ancillary processes such as NaOH production, limestone mining, lime calcination, petrol coke production, pitch production, and AlF3 production. See litterature references (LitteratureRef) next to the flow table (FlowMetaData) for further information about the data sources for each process step.
Other Boundaries	See Nature boundaries for a specification of the cut-off criteria that has been applied. The production of alloying metals and fluxing agents is not included in this data set. The energy use presented as electricity (nuclear and hydro) in the inventory table includes the energy loss in the distribution net. The production of electricity by nuclear and hydro is however not included.
Allocations	Allocations are not explicitly specified in the Environmental Profile Report 2000.
Systems Expansions	System expansions are not explicitly specified in the Environmental Profile Report 2000.

Flow Data

General Activity QMetaData

Date Conceived	1989-1999
Data Type	Derived, unspecified
Represents	See LitteratureRef.
Method	The data is taken from the report ''Environmental Profile Report for the European Aluminium Industry'', European Aluminium Association, April 2000. INTERPRETATION OF FLOW TYPE AND ENVIRONMENT FOR INPUT FLOWS Several of the input flows is ambigously presented in the report. It is not clear whether they should be regarded as natural resources or refined resources. The interpretation in the documentation in this format is made based on the naming of the flows, e.g. steel bars is not considered to be a natural resource, and the description of included process steps. DATA SOURCES IN THE EAA-REPORT The sources of the various figures are aluminium company data in all cases in which the industry is directly involved in production. For other ancillary materials the data are in most cases supplied by the manufacturers of the products, but not necessarly all the plants supplying the European market. LCI data for primary aluminium production in this study derive from a survey for 1995, covering 92% of total European primary aluminium output. Another survey was carried out in 1998, covering 98% of the total European primary aluminium output, concentrating on parameters likely to have changed since 1995, i.e. about 30 major consumption or emission data items. The data is collected from the aluminium companies in all cases where this industry is directly involved in the production. For other ancillary materials the data are in most cases collected from the manufacturers of the products, but not necessarly all the plants supplying the European market. For those cases where EAA members' manufacturers' data were not available, published data have been used. See litterature references (LitteratureRef) next to the flow table (FlowMetaData) for information about the data sources from which the inventory parameters is derived. In addition to the figures provided by the EAA members, data has also been collected from elsewhere for the process steps in which the European aluminium industry is not involved, published data have been used, as referenced below: - Bauxite mining: BUWAL Environmental series no. 132 (1991), IPAI Bauxite Mine survey, other sources - Limestone production: I. Fecker, EMPA (1989), BUWAL Environmental series no. 132 (1991), Pechiney (1994), VAW (1994) - Caustic soda production: I.Boustead. Ecoprofiles of plastics and related intermediates, APME Brussels (1999) - Aluminium fuoride production: Norzinc/Alufluor/Pechiney (1994) - Petrol coke production: Pechiney (1994), APME report no.2 (1995), Statoil (Norway, 1995) - Pitch production: Hoogovens Staal, note 21 November 1997 METHOD FOR CALCULATION AND PRESENTATION OF ENERGY RESOURCES IN THE INVENTORY TABLE The procedure for calculating and presenting the input parameters (energy carriers) brown coal, hard coal, natural gas, and crude oil in the inventory table is presented below. It is based on the tables in the EAA report (see litterature reference). Each of the input parameters stated are described in the inventory table and related note field according to this procedure: A. Summary of the total energy resources for each energy carrier, respectively(from table 2.4 or 7.2) B. Statement of how many kg that are used for transport, process, and production of fuel and electricity (from table 2.4 or 7.2) C. Division of the energy resource input on the different process steps and statement on how much that are used for heat, electricity, feedstock and/or other (from table 7.2) D. Division of the transport data in to the various types of transports means in the different process steps (from table 7.2) METHOD FOR PRESENTATION OF SUBSTANCES, EXCEPT ENERGY RESOURCES The substances stated in the table is flows to the system as a whole, described in Function. In order to get information about the relevant connection of a substance to a process step, see Note for each specific flow. Further information regarding the contribution to a flow from a specific process step can be found in table 7.2 and 7.3 in the Environmental Profile Report, see Literature reference. However, due to the presentation form in the Environmental Profile Report, it is not possible to separate the data for all the process steps completely. SIGNIFICANT NUMBERS The numbers stated in this table is taken directly from the EAA report (see litterature reference), except for the energy resources, which is taken from the EAA report but recalculated as described above in ''Method for calculation and ...''. For the energy resources two significant numbers are always stated in the inventory table. This was chosen because of insufficient specification of the significant numbers stated in the report. For further details about the calculation and rounding, see Method for the specific flow. ELECTRICITY PRODUCTION MODEL FOR ELECTROLYSIS (PRIMARY SMELTER) A model for

	electricity production has been applied to this system, in accordance with the fact that about 40% of the primary aluminium used in Europe is imported (19% from Russia and 20% from the western world outside Europe, during the years 1990-1999). In the table below the share of aluminium produced in Europe, Russia and the West world (except Europe) is presented. Further, a specification of the electricity production model that has been used for the respective parts is presented. Smelters: European Russian West world (exc. Eur.) Total model Share of aluminium produced: 61% 19% 20% 100% Energy resources: brown coal 7,7% 16,1% - 5,1% hard coal 17,5% - 30,9% 20,0% natural gas 5,5% - 7,1% 4,6% crude oil 5,1% - 0,7% 3,1% nuclear electricity 23,6% 2,2% 0,4% 14,6% hydroelectricity 40,5% 81,7% 60,9% 52,6% Total 100% 100% 100% 100% The electricity supply systems have been taken from SAEFL Environmental Series 250 (1998) ''Buwal 250'' and EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems. Electricity used in Russian primary aluminium production is taken from a report by J. Schäfer (GDA, 1998) (a full reference to this report is not supplied in the Environmental Profile Report 2000). ELECTRICITY MODEL OUTSIDE ELECTROLYSIS AND CAST HOUSE OPERATIONS For all manufacturing operation other than electrolysis and cast house, the consumption of fossil fuels and emissions linked to electricity production was calculated according to the UCTPE 94 electrical energy model as described in BUWAL 250.
Literature Reference	- ''Environmental Profile Report for the European Aluminium Industry'', European Aluminium Association, April 2000. - Bauxite mining: BUWAL Environmental series no. 132 (1991), IPAI Bauxite Mine survey, other sources - Limestone production: I. Fecker, EMPA (1989), BUWAL Environmental series no. 132 (1991), Pechiney (1994), VAW (1994) - Caustic soda production: I.Boustead. Ecoprofiles of plastics and related intermediates, APME Brussels (1999) - Aluminium fuoride production: Norzinc/Alufluor/Pechiney (1994) - Petrol coke production: Pechiney (1994), APME report no.2 (1995), Statoil (Norway, 1995) - Pitch production: Hoogovens Staal, note 21 November 1997 - SAEFL Environmental Series 250 (1998) ''Buwal 250'' - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems - Electricity used in Russian primary aluminium production is taken from a report by J. Schäfer (GDA, 1998)
Notes	The residues arising in alumina production often called ''red mud'', have been separated into major constituents, the main one being bauxite residue, which is a mixture of chemically inert mineral oxides.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: The substance is used in the alumina production.	Input	Natural resource	Bauxite	4111			kg	Ground	
Method: The numerals are taken from the inventory table 2.4 and 7.4 in the Environmental Profile Report. The total summary for brown coal is 1,0*10^2 kg (25,5 + 70,4 + 0,04 + 4,4 + 1,3) kg = 101,64 kg --> 1,0*10^2 kg (with two significant numbers) Notes: The energy resource is used for: - Production of fuel (25,5 kg, thermal energy) and electricity (70,4 kg), except production of electricity by nuclear and hydro (these flows are presented separately) - Transportation of bauxite (4,4 kg), alumina (1,3 kg), and other (0,04 kg) The energy resources for transports are further described with details regarding how much e.g. coal that are used on sea, road, and rail transport respectively, and in which process step. SEA Transports within the Production of alumina (aluminium oxide) process step: 0,03 kg Bauxite transport: 3,5 kg Alumina transport: 0,9 kg ROAD Transports within the Production of alumina (aluminium oxide) process step: 0,01 kg Bauxite transport: 0,7 kg Alumina transport: 0,02 kg RAIL Transports within the Production of alumina (aluminium oxide) process step: - Bauxite transport: 0,2 kg Alumina transport: 0,4 kg	Input	Natural resource	Brown coal	1.0E2			kg	Ground	
	Input	Natural resource	Crude coal	133.3			kg	Ground	
Method: The numerals are taken from the inventory table 2.4 and 7.4 in the Environmental Profile Report. The total summary for crude oil is 7,2*10^2 kg (546,3 + 18,8 + 21,3 +136,5 + 1,6) kg = 724,5 kg --> 7,2*10^2 kg (with two significant numbers) Notes: The energy resource is used for: - Production of fuel (546,3 kg, thermal energy) and electricity (18,8	Input	Natural resource	Crude oil	7.2E2			kg	Ground	

kg), except production of electricity by nuclear and hydro (these flows are presented separately) - Transportation of bauxite (21,3 kg), alumina (136,5 kg), and other (1,6 kg) The energy resources for transports are further described with details regarding how much e.g. crude oil that are used on sea, road, and rail transport respectively, and in which process step. SEA Transports within the Production of alumina (aluminium oxide) process step: 0,6 kg Bauxite transport: 72,8 kg Alumina transport: 18,9 kg ROAD Transports within the Production of alumina (aluminium oxide) process step: 1,0 kg Bauxite transport: 63,5 kg Alumina transport: 2,0 kg RAIL Transports within the Production of alumina (aluminium oxide) process step: - Bauxite transport: 0,2 kg Alumina transport: 0,4 kg									
Method: The numerals are taken from the inventory table 2.4 and 7.4 in the Environmental Profile Report. The total summary for hard coal is 1,2*10^2 kg (46,0 + 67,4 + 0,08 + 7,5 + 1,6) kg = 122,58 kg --> 1,2*10^2 kg (with two significant numbers) Notes: The energy resource is used for: - Production of fuel (46,0 kg, thermal energy) and electricity (67,4 kg), except production of electricty by nuclear and hydro (these two flows are presented separately) - Transportation of bauxite (7,5 kg), alumina (1,6 kg), and other (0,08 kg) The energy resources for transports are further described with details regarding how much e.g. coal that are used on sea, road, and rail transport respectively, and in which process step. SEA Transports within the Production of alumina (aluminium oxide) process step: 0,03 kg Bauxite transport: 4,1 kg Alumina transport: 1,1 kg ROAD Transports within the Production of alumina (aluminium oxide) process step: 0,05 kg Bauxite transport: 3,2 kg Alumina transport: 0,10 kg RAIL Transports within the Production of alumina (aluminium oxide) process step: - Bauxite transport: 0,2 kg Alumina transport: 0,4 kg	Input	Natural resource	Hard coal	1.2E2			kg	Ground	
Notes: The substance is used in the alumina production.	Input	Natural resource	Limestone	159.4			kg	Ground	
Method: The numerals are taken from the inventory table 2.4 and 7.4 in the Environmental Profile Report. The total summary for natural gas is 1,0*10^2 kg (91,0 + 10,2 + 0,023 + 2,5 + 0,62) kg = 104,343 kg --> 1,0*10^2 kg (with two significant numbers) Notes: The energy resource is used for: - Production of fuel (91,0 kg, thermal energy) and electricity (10,2 kg), except production of electricity by nuclear and hydro (these flows are presented separately) - Transportation of bauxite (2,5 kg), alumina (0,62kg), and other (0,023 kg) The energy resources for transports are further described with details regarding how much e.g. natural gas that are used on sea, road, and rail transport respectively, and in which process step. SEA Transports within the Production of alumina (aluminium oxide) process step: 0,006 kg Bauxite transport: 2,1 kg Alumina transport: 0,55 kg ROAD Transports within the Production of alumina (aluminium oxide) process step: 0,017 kg Bauxite	Input	Natural resource	Natural gas	1.0E2			kg	Ground	

transport: 0,4 kg Alumina transport: 0,01 kg RAIL Transports within the Production of alumina (aluminium oxide) process step: - Bauxite transport: 0,0 kg Alumina transport: 0,06 kg									
Notes: The substance is used in the alumina production.	Input	Natural resource	Salt	88.8			kg	Ground	
Method: From table 7.2 Overall inventory LCI table: bauxite mining to electrolysis, including cast house and transport:input (see litterature reference for EAA report in General QMetaData) the following calculations ha been made: Water for cooling 15,2 m3 + water for consumption 0,87 m3 = 16,7 m3, which becomes 16 m3 with two significant numbers. Notes: The substance is used in the alumina production, paste and anode plant, and cathode relining.	Input	Natural resource	Water	16			m3	Water	
Notes: The substance is used in the alumina production.	Input	Refined resource	Acid	8.7			kg	Technosphere	
Notes: The substance is used in the cast house.	Input	Refined resource	Alloying elements	10.8			kg	Technosphere	
Notes: The substance is used in the electrolysis.	Input	Refined resource	Aluminium hydroxide	12.5			kg	Technosphere	
Notes: The unit was not specified in table 7.2 from which the value is acquired from the report. However, all other flows are presented in kg. The substance is used in the cathode relining.	Input	Refined resource	Aluminium oxide	0.4			kg	Technosphere	
Notes: The substance is used in the cast house.	Input	Refined resource	Ar-gas	1.5			kg	Technosphere	
Notes: The unit was not specified in table 7.2 from which the value is acquired from the report. However, all other flows are presented in kg. The substance is used in the cathode relining.	Input	Refined resource	Blasting material	0.4			kg	Technosphere	
Notes: The substance is used in the electrolysis.	Input	Refined resource	Calcium fluoride	27.1			kg	Technosphere	
Notes: The substance is used in the cathode relining.	Input	Refined resource	Carbon blocks	7.5			kg	Technosphere	
Method: From table 7.2 Overall inventory LCI table: bauxite mining to electrolysis, including cast house and transport:input (see litterature reference for EAA report) the following calculations ha been made: Cast iron in electrolysis 3,5 kg + cast iron in cathode relining = 4,3 kg, which becomes 4 kg with one significant number. Notes: The substance is used in the electrolysis and cathode relining.	Input	Refined resource	Cast iron	4			kg	Technosphere	
Notes: The substance is used in the cast house.	Input	Refined resource	Cl2 gas	0.10			kg	Technosphere	
Notes: The substance is used in the electrolysis and cathode relining.	Input	Refined resource	Collar paste	6.5			kg	Technosphere	
Notes: The substance is used in the electrolysis.	Input	Refined resource	Cryolite	1.6			kg	Technosphere	
Method: The numerals are taken from the inventory table 2.4 and 7.4 in the Environmental Profile Report. The total summary for electricity is 3,6*10^2 kWh (243,2 + 9,6 + 3,2 + 99,0) kWh = 355 kWh --> 3,6*10^2 kWh (with two significant numbers) Notes: 255 kWh is nuclear electricity (243,2 kWh for electricity production and 9,6 kWh for transport of bauxite and 3,2 kWh for transport of alumina) and 99,0 kWh is hydroelectricity.	Input	Refined resource	Electricity	3.6E2			kWh	Technosphere	
Notes: The substance is used in the cast house.	Input	Refined resource	Fibre materials	0.11			kg	Technosphere	
Notes: The substance is used in the cast house.	Input	Refined resource	Fluxing salts	0.40			kg	Technosphere	

Notes: The substance is used in the cast house.	Input	Refined resource	Mineral/vegetal oil	0.08			kg	Technosphere	
Method: From table 7.2 Overall inventory LCI table: bauxite mining to electrolysis, including cast house and transport:input (see litterature reference for EAA report) the following calculations ha been made: 0,08 kg N2 in alumina production + 0,60 kg N2 in cast house = 0,68 kg, which becomes 0,7 kg with one significant number. Notes: N2 gas. The substance is used in the alumina production and Cast house.	Input	Refined resource	N2	0.7			kg	Technosphere	
Notes: The substance is used in the electrolysis.	Input	Refined resource	NaCO3	1.4			kg	Technosphere	
Notes: The substance is used in the alumina production.	Input	Refined resource	Organic components	1.1			kg	Technosphere	
Notes: The substance is used in the cast house.	Input	Refined resource	Packaging materials	1.80			kg	Technosphere	
Notes: The substance is used in the alumina production.	Input	Refined resource	Potassium chloride	3.0			kg	Technosphere	
Notes: The substance is used in the paste/anode plant, cathode relining, and cast house.	Input	Refined resource	Refractory materials	15.2			kg	Technosphere	
Notes: The substance is used in the cathode relining.	Input	Refined resource	Steel bars	5.1			kg	Technosphere	
Notes: The substance is used in the electrolysis.	Input	Refined resource	Sulphuric acid	31.4			kg	Technosphere	
Notes: Al203 residue for reuse.	Output	By-product	Al203 residue	0.40			kg	Technosphere	
Notes: Carbon material for fuel and recycling.	Output	By-product	Carbon material	21.4			kg	Technosphere	
	Output	By-product	Crushed bath sold	4.1			kg	Technosphere	
Notes: Dross and skimmings for recycling (metal yield 48%).	Output	By-product	Dross and skimmings	18.6			kg	Technosphere	
Notes: SPL carbon fuel/reuse. No specification of SPL is given in the report	Output	By-product	SPL carbon	6.6			kg	Technosphere	
Notes: SPL refractory bricks, reuse No specification of SPL is given in the report	Output	By-product	SPL refractory	1.7			kg	Technosphere	
	Output	By-product	Steel scrap	7.0			kg	Technosphere	
	Output	By-product	Swarf/turnings	0.84			kg	Technosphere	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	BOD	0.0024			kg	Water	
Method: The numerals are taken from the inventory table 2.4 and 7.4 in the Environmental Profile Report. (2,85 + 0,61) kg = 3,46 kg --> 3,5 kg (with two significant numbers) Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	CH4	20			kg	Air	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Chlorides	56			kg	Water	
Method: The numerals are taken from the inventory table 2.4 and 7.4 in the Environmental Profile Report. (2,85 + 0,61) kg = 3,46 kg --> 3,5 kg (with two significant numbers) Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	CO	96			kg	Air	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	CO2	10 634			kg	Air	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	COD	0.23			kg	Water	
Notes: The substance is emitted from the electrolysis.	Output	Emission	Cyanide	0.00063			kg	Water	

Notes: The substance is emitted from the alumina production.	Output	Emission	Dissolved solids	1.73			kg	Water	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Dust	27			kg	Air	
Notes: The substance is emitted from the electrolysis.	Output	Emission	F total	1.24			kg	Air	
Notes: The substance is emitted from the electrolysis.	Output	Emission	H+	0.018			kg	Water	
Notes: HC, other than PAH. The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	HC	0.016			kg	Water	
Notes: The substance HC includes all hydrocarbons except CH4 and PAH. The substance is emitted both from the alumina production and the electrolysis. 0,000 2 kg is air emission from the bauxite mining and alumina production process, 2,9 kg is from the transport of bauxite and alumina, 4,52 kg is from the fuel production and combustion, and 0,33 kg is from the production of electricity.	Output	Emission	HC	9.9			kg	Air	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	HCl	1.4			kg	Air	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	HF	0.75			kg	Air	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Hg	0.00022			kg	Air	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Hg	7E-6			kg	Water	
Notes: The substance is emitted from the alumina production.	Output	Emission	K+	0.089			kg	Water	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	N2O	0.0032			kg	Air	
Notes: The substance is emitted from the alumina production.	Output	Emission	Na+	9.3			kg	Water	
Notes: NH3, ammonia. The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	NH3	0.023			kg	Air	
Notes: Ammonium (NH4+). The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	NH4+	0.060			kg	Water	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	NO3-	0.24			kg	Water	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	NOx	27			kg	Air	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Oil/grease	1.13			kg	Water	
Notes: Other metals emitted to air are Cd, Fe, Mn, Ni, Pb, Zn etc. The substance is not further specified in the report. The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Other metals	0.5			kg	Air	
Notes: Other metals emitted to water as Al, As, Ba, Cd, Cr, Cu, Fe, Ni, Zn etc. No further specification is given in the report. The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Other metals	8.6			kg	Water	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	PAH	0.014			kg	Water	
Notes: The substance PAH includes B(a)P. No further specifiction is found in the report. The substance is emitted both from the alumina production and	Output	Emission	PAH	3.3			g	Air	

the electrolysis.									
Notes: The substance PFC consists of approx. 90% CF4 and 10% C2F6. No explanation of the term PFC is given in the report. The substance is emitted from the electrolysis.	Output	Emission	PFC	0.28			kg	Air	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Phenol	0.0061			kg	Water	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Phosphate	0.17			kg	Water	
Date concieved: 1998 Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	SO2	71.6			kg	Air	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Sulphates	34			kg	Water	
Notes: The substance is emitted both from the alumina production and the electrolysis.	Output	Emission	Suspended particles	4.4			kg	Water	
	Output	Product	Aluminium ingot	1000			kg	Technosphere	
Notes: The residue derives from the alumina production.	Output	Residue	Bauxite residue	1286			kg	Technosphere	
Notes: The residue derives from the electrolysis.	Output	Residue	Carbon waste	3.9			kg	Technosphere	
Notes: No specification of the substance is given in the report. The residue derives from the electrolysis.	Output	Residue	Dross fines	0.11			kg	Technosphere	
Notes: Dust from cyclones/ESP. The residue derives from the electrolysis.	Output	Residue	Dust	2.0			kg	Technosphere	
Notes: The residue derives from the electrolysis.	Output	Residue	Hazardous waste	0.32			kg	Technosphere	
Notes: Na as Na2O.	Output	Residue	Na2O	14.8			kg	Technosphere	
Notes: The residue derives from the alumina production.	Output	Residue	Na-oxalate	6.0			kg	Technosphere	
Notes: The residue derives from the electrolysis.	Output	Residue	Refrectory waste	7.0			kg	Technosphere	
Notes: The residue derives from the alumina production.	Output	Residue	Sand	98			kg	Technosphere	
Notes: The residue derives both from the alumina production and the electrolysis.	Output	Residue	Solid waste unspecified	64			kg	Technosphere	
	Output	Residue	Soot	1.2			kg	Technosphere	
Notes: No specification of the substance is given in the report The residue derives from the electrolysis.	Output	Residue	SPL carbon	7.7			kg	Technosphere	
Notes: No specification of the substance is given in the report The residue derives from the electrolysis.	Output	Residue	SPL refractory	15.2			kg	Technosphere	
Notes: The residue derives from the electrolysis.	Output	Residue	Tar waste	0.41			kg	Technosphere	

About Inventory

Publication	Environmental Profile Report for the European Aluminium Industry, European Aluminium Association, April 2000 -- Data documented by: Maria Erixon, IMI, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 8 May 2002 --
Intended User	LCA-practitioners.
General Purpose	The European Aluminium Association (EAA) aims to contribute to further environmental improvements in aluminium products in a life cycle concept.

Detailed Purpose	The purpose with the Environmental Profile Report 2000 is to provide LCA-practitioners with detailed and up-to-date information representing the aluminium industry activities in Europe. The purposes with formatting the Environmental Profile Report 2000 for the European Aluminium Industry to the data documentation format SPINE, according to the data documentation criteria applied at Centre for environmental assessment of Product and Material systems (CPM) are: - CPM and European Aluminium Association (EAA) are anxious to provide life cycle assessment (LCA) practitioners with accurate and up to date environmental data for aluminium production. - EAA is interested in the SPINE formatting procedure and result, as the format is a base for (and therefor somewhat similar to) the new Technical Specification in ISO, ISO 14048, regarding LCA data documentation format. - EAA is interested in the CPM data quality control and documentation criteria.
Commissioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Practitioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Reviewer	Dr. Ian Boustead, - 2 Black Cottages West Grinstead, Horsham GB-West Sussex RH13 7BD
Applicability	--- SPECIFIC INFORMATION FOR THIS DATA SET --- INFORMATION ABOUT THE SYSTEM This system represents the European average situation, which uses about 15% Söderberg technology (anode consists of söderberg paste) and 85% Prebake technology (newer and cleaner technology with solid anodes) in the electrolysis. The electrolysis, also referred to as the smelter, is by far the most energy consuming process in primary aluminium production. About 40% of the primary aluminium used in Europe is imported (19% from Russia and 20% from the western world outside Europe, during the years 1990-1999). An European model for electricity production has been applied to this system, according to this information. See headline Method under the section General QMetaData to get more information about the European electricity production model. CASTING At present cast houses in this industry vary significantly in age and size, and produce a wide variety of products and alloys. It has not been possible to produce one set of figures for every type of product and alloy, figures for a basic cast house have therefore been worked out, i.e. typically yielding primary aluminium ingot for rolling, extrusion or remelting. Data relative to specific further treatment of rolling and extrusion ingots, such as homogenisation, sawing, scalping etceteras are covered in later process steps, in the semi-finished product sections, also documented in SPINE format, see headline Semi-finished aluminium product fabrication above. ENERGY USE IN THE DIFFERENT INCLUDED PROCESS STEPS The energy directly consumed by the operations enclosed within the system bounderies, i.e. in the various production steps, are presented below. See the headline ''DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION'' in About Data for further information. ---3. Production of alumina (aluminium oxide) --- Fuel oil (kg) 487,5 Hard coal (kg) 16,4 Gas (kg) 65,1 Electricity UCTPE* (kWh) 602,0 ---5. Electrolysis--- Fuel oil (kg) 5,1 Gas (kg) 1,8 Electricity EAA-mix (kWh) 15574 Electricity UCTPE* (kWh) 2,6 ---5.1. Anode production, including anode butt recycling and transport to Electrolysis--- Fuel oil (kg) 25,7 Hard coal (kg) 2,0 Gas (kg) 65,3 Electricity UCTPE* (kWh) 84,3 ---5.2. Cathode production and transport to Electrolysis --- Fuel oil (kg) 0,1 Gas (kg) 0,6 Electricity UCTPE* (kWh) 4,0 ---6. Casting--- Fuel oil (kg) 10,5 Gas (kg) 13,9 Electricity EAA-mix (kWh) 16

* UCTPE 94 is an electrical energy model for energy supporting all processes in this system (including transports), except electrolysis and cast house. It is described in BUWAL 250, see litterature references.

--- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 ---

RECOMMENDATIONS BY EAA WHEN USING THE DATA

The data provided by the EAA members for their own process steps are the most up-to-date average data available for these processes, and it is recommended that they be used for LCA purposes. Older literature data should be disregarded, as it may no longer be representative due to technological improvements, progress in operating performance, changes with regard to raw materials or waste treatment, etc.

To complete the product system inventory, data
- on the production of consumer products, from semi-fabricated aluminium,
- on the performance of consumer products in the use phase, and
- on the recovery of scrap prior to remelting at the end of the product’s useful life
should be acquired.

EAA recommend that these data be used in LCA studies in accordance with methodologies within the framework of the international standards in the ISO 14040-series.

RELATED DATA SETS IN SPINE DATA FORMAT

The data presented in the Environmental Profile Report is reformatted in to the SPINE format and structured according to the SPINE concept in as many separate activities (sub-systems) as possible. The system scope for the study as a whole is primary aluminium production, semi-finished aluminium production, and recycling. The SPINE formatting resulted in 7 activities. These activities are all published in the SPINE@CPM database.

The production and recycling step are intended to be used together. For example, to obtain a cradle to gate-system for rolled aluminium sheet, the activity Primary aluminium production should be connected to the activity Production of rolled aluminium sheet. A recycling step (Aluminium recycling by refiners) could also be connected to such a system, depending on the scope.

-- List of activities formatted in the SPINE-format, published in SPINE@CPM --

Primary aluminium production
1. Primary aluminium production

Semi-finished aluminium product fabrication
2. Production of rolled aluminium sheet
3. Production of extruded aluminium profiles
4. Production of 0,02-0,2 mm single-rolled aluminium foil
5. Production of 0,005-0,02 mm double-rolled aluminium foil

Recycling
6. Re-melting of aluminium scrap
7. Aluminium recycling by refiners

Please note: The recycling process 6. Re-melting of aluminium scrap is included in the semi-finished aluminium product fabrication, i.e. activities 2-5. When designing a product system with the activities above where recycled aluminium is regarded, the activity Aluminium recycling by refiners should be used. The Re-melting of aluminium activity is only a specification if the user is specifically interested in this process step.

RECYCLING RATES FOR ALUMINIUM PRODUCTS AFTER USE

After use, aluminium products are a valuable re-usable resource. The European recycling rates for end products are currently around 95% for the automotive sector and 85% for the building sector.

IMPROVEMENTS IN THE ENVIRONMENTAL PERFORMANCE OF ALUMINIUM PRODUCTS AND PROCESSES OVER THE PAST FEW YEARS

Over the past few years EAA has achieved major improvements in the environmental performance of its production processes by means of the following:
- improvement on existing technology
- development and introduction of new technology and operations
- increased recycling of all materials in the production process.

Examples of major environmental improvements in aluminium products achieved over the past few years include:
- weight reduction by downgauging in the packaging sector
- energy savings through weight reduction and subsequent fuel reduction in the transport sector
- reduction of maintenance in the building sector

The previous Ecological Profile Report from EAA was published in 1996.

About Data	
	--- SPECIFIC INFORMATION FOR THIS DATA SET ---

DATA SOURCES

The sources of the various figures are aluminium company data in all cases in which the industry is directly involved in production. For other ancillary materials the data are in most cases supplied by the manufacturers of the products, but not necessarly all the plants supplying the European market.

In addition to the figures provided by the EAA members, data has also been collected from elsewhere for the process steps in which the European aluminium industry is not involved, i.e.:
- Bauxite mining
- Limestone production
- Caustic soda production
- Aluminium fluoride production
- Petrol coke production
- Pitch production

For those cases where EAA members' manufacturers' data were not available, published data have been used, see literature references.

DATA COLLECTION

The data is based on two surveys performed 1995 and 1998. LCI data for primary aluminium production derive from a survey for 1995, covering 92% of total European primary aluminium output. Another survey was carried out in 1998, covering 98% of the total European primary aluminium output, concentrating on parameters likely to have changed since 1995, i.e. about 30 major consumption or emission data items.

No data for the production of alloying metals and fluxing agents (added in the casthouse) is included in this data set.

AGGREGATION METHOD

Horizontal aggregation, i.e. averaging between primary plants for each fabrication step has been used in this report. This is chiefly because, apart from bauxite delivered to alumina plants, the supply of raw material to each individual plant varies with time (the bauxite supply to alumina production is relatively constant while the supply to other later process steps varies). The alternative would have been vertical aggregation, i.e. averaging the total production data for each smelter from bauxite, through the alumina plant and down to the smelter itself. However, the variation between the alumina plants, regarding the environmental profile, is in the range of +/- 15%, and as such would not have altered the overall result.

--- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 ---

PRECISION

According to EAA, the environmental data figures in the inventory table are usually accurate to a precision of 5%.

DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION

The electricity supply systems and fuel production and use (transport energy and emission data) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250' and EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems.

All emissions connected with total fuel consumption (i.e. production and combustion of oil, gas or coal) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250', table 16.9. Emissions from combustion only, i.e. excluding the contribution of the production of the fuel, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of production and combustion of fuels in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, in view of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors.

REVIEW OUTSPOKE

Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, April 2000, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. Ian Bousteds' review comments on the Environmental Profile Report for the European Aluminium Industry, April 2000:

''...I have received the detailed calculations on which this present environmental report is based. All of the queries that I raised after working through these reports were answered satisfactory.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000

''Good-quality data were supplied by the EAA member companies, and the number of companies participating provides good coverage of the various processes, meaning that the

	results can be regarded as representative of the industryas a whole for the production of primary aluminium and subsequent conversion processes.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Because of the very fragmented nature of the recycling industry and wide variations in practices, it is recognised that the data presented for this sector of the industry can only be regarded as indicative. Nevertheless it is helpful to have such information from an authorative source.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000
Notes	REVIEWER Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. See AboutData for review comments.

SPINE LCI dataset: Printed board assembly

Administrative	
Finished	Y
Date Completed	2000-03-07
Copyright	Ericsson
Availability	Official

Technical System	
Name	Printed board assembly
Functional Unit	One m2 (square meter) printed board.
Functional Unit Explanation	The motivation for choosing this functional unit is: · suitable unit to work with in an LCA of a private branch exchange (a complicated telecom product) · important component of the MD110 product system and many other electronic products. DESIGN These facts are based on Ericsson technical specification of the component. Ericsson product number: TVM 113 5338 Ericsson description: Printed board General technical specification Dimension: 221.9 mm x 178.1 mm (i.e. app. 3.952 dm2) Number of layers: 4 Flammability rating: UL94V-0 Surface protection: Hot dip tinning Thickness without mask: 1.68 mm Weight: 137 g
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of a printed board. The activity is an average based on information acquired from two manufacturers. The description of the process is supplied by manufacturer one, but is assumed to be general for this type of manufacture. The following process steps are included; Innerlayer manufacturing process: 1. Chemical pre-treatment 2. Punching of steering holes 3. Photoresistlamination

	4. Exponation 5. Developing of photoresist 6. Etching 7. Photoresiststripping 8. Automatic Optical Inspection, AOI 9. Brown oxidation 10. Heat treatment 11. Blading 12. Preassuring-after hardening 13. Baking 14. Steer hole taking 15. Clean sawing Hole metallized including multilyer board manufacturing process: 1. Affix-hole drilling 2. Component hole drilling 3. Direct metallization 4. Panel plating (of copper) 5. Chemical copper plating 6. Photoresistlamination 7. Electrified panel plating of copper 8. Electro tinning 9. Stripping 10. Etching 11. Tin stripping 12. Stone polishing 14. Automatic optical inspection 15. Stone polishing 16. Solder masking 17. Exponation 18. Pre-hardening 19. Developing 20. UV-hardening 21. Finishing hardening 22. Oxide protection 23. Electricity test 24. Contour treatment 25. Inspection 26. Packing According to CM1 these amounts of waste are recycled in the processes: Waste from photographical processes 13.3 g/m2 printed board area, Etchbaths 6913.2 g/m2, Oil (unspecified) 247.7 g/m2, NH3 3542.5 g/m2 and aluminium 0.4 g/m2. Detailed description in Swedish was given by manufacturer one (CM1). Manufacturer two (CM2) gave information about which process steps that occurred but no detailed information.

System Boundaries	
Nature Boundary	The emissions to air and water have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impacts have been studied. Both included component manufacturers answers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used.
Time Boundary	1998 The answer from the manufacturer arrived in 1998 and they measured in 1998. The process technology used is most certainly the best available as the factories are located in Sweden and Italy and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturers included in the average are located in Sweden and Italy.
Other Boundaries	Delimitations to the system is the final step in the making of the printed board. The production of the subparts (e.g. laminate, galvanic copper and soldermask) of the printed board is not included in this model The transportation of them to the factory is not included. For interested parties who which wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability.
Allocations	The manufacturers have not described how the allocation has been made. Component manufacturer one (CM1) stated that the production of the product we asked for constituted 1% of total manufactured printed board area during 1998. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	See LitteratureRef.
Method	The data that are presented are calculated as a average based on information from two component manufacturers. The information from the manufacturers was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers In the information supplied by the manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+..+.ACn Step 2: The sum AC11+..+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to two answers was made.
Literature Reference	- ''Environmental Profile Report for the European Aluminium Industry'', European Aluminium Association, April 2000. - Bauxite mining: BUWAL Environmental series no. 132 (1991), IPAI Bauxite Mine survey, other sources - Limestone production: I. Fecker, EMPA (1989), BUWAL Environmental series no. 132 (1991), Pechiney (1994), VAW (1994) - Caustic soda production: I.Boustead. Ecoprofiles of plastics and related intermediates, APME Brussels (1999) - Aluminium fuoride production: Norzinc/Alufluor/Pechiney (1994) - Petrol coke production: Pechiney (1994), APME report no.2 (1995), Statoil (Norway, 1995) - Pitch production: Hoogovens Staal, note 21 November 1997 - SAEFL Environmental Series 250 (1998) ''Buwal 250'' - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems - Electricity used in Russian primary aluminium production is taken from a report by J. Schäfer (GDA, 1998)
Notes	CM1 = component manufacturer one, factory located in Sweden CM2 = component manufacturer two, factory located in Italy

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.16 g Weight of board, CM1: 157.9 g 0.16 g/157.9 g = 0.001 g/g 0.16 g/0.03952 m2 = 4.05 g/m2	Input	Refined resource	Al	4.05			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 10 g Weight of board, CM1: 157.9 g 10 g/157.9 g = 0.063 g/g 10 g/0.03952 m2 = 253.04 g/m2	Input	Refined resource	Aqua flux	253.04			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 20 g Weight of board, CM1: 157.9 g 20 g/157.9 g = 0.127 g/g 20 g/0.03952 m2 = 506.08 g/m2	Input	Refined resource	Aqua oil	506.08			g	Technosphere	
Date concieved: 1994 Data type: Derived, unspecified Method: CM1: 40 g Weight of board, CM1: 157.9 g 40 g/157.9 g = 0.2532 g/g 40 g/0.03952 m2 = 1012.16 g/m2	Input	Refined resource	Ca(OH)2	1012.16			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1 uses 3680 Wh (Central heating) for one printed board of 0,0395 m2 which weighs 157.91 grams. 3680 Wh/0.03952 m2 = 93117.4 Wh/m2 3680 Wh/157.91 g = 23.3 Wh/g Notes: This flow refers to central heating in the factory generated by burning of biofuel.	Input	Refined resource	Central heating	93117.4			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 34.3 g (20 g Copperpellets and 14.3 g Copperfoil) Weight of board, CM1: 157.9 g 34.3 g/157.9g = 0.22 g/g 34.3 g/0.03952 m2 = 867.91 g/m2 CM2: 115 g (68	Input	Refined resource	Copper	1888.91			g	Technosphere	

grams of base material copper plus 47 grams of galvanic copper) Weight of board, CM2: 160.59 g 115 g/160.59 = 0.72 g/g 115 g/0.03952 m2 = 2909.91 g/m2 Both boards have surface: 0,03952 m2 MASS, (CM1+CM2)/2 = 0.47 g/g SURFACE, (CM1+CM2)/2 = 1888.91 g/m2 One can choose which model one like, surface or mass.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1 uses 9870 Wh for one printed board of 0,0395 m2 which weighs 157.91 grams. 9870 Wh/0.03952 m2 = 249747 Wh/m2 9870 Wh/157.91 g = 62.5 Wh/g Component manufacturer two (CM2) did not state electricity consumption. Notes: Swedish average electricity.	Input	Refined resource	Electricity	249747			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 20 g Weight of board, CM1: 157.9 g 20 g/157.9 g = 0.127 g/g 20 g/0.03952 m2 = 506.08 g/m2 Notes: ferric chloride has CAS number 7705-08-0.	Input	Refined resource	ferric chloride	506.33			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1.7 g (The film is of acrylate) Weight of board, CM1: 157.9 g 1.7 g/157.9g = 0.01 g/g 1.7 g/0.03952 m2 = 0.25 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	Film	0.25			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 86.2 g Weight of board, CM1: 157.9 g 86.2 g/157.9g = 0.54 g/g 86.2 g/0.03952 m2 = 2181.17 g/m2 CM2: 68 g Weight of board, CM2: 160.59 g 68 g/160.59 = 0.42 g/g 68 g/0.03952 m2 = 1720.65 g/m2 Both boards have surface: 0,03952 m2 MASS, (CM1+CM2)/2 = 0.48 g/g SURFACE, (CM1+CM2)/2 = 1950.91 g/m2 One can choose which model one like, surface or mass. The laminate consists of glass fibre armed epoxy plastic.	Input	Refined resource	FR4 laminate	1950.91			g	Technosphere	
Date concieved: 1994 Data type: Derived, unspecified Method: CM1: 340 g Weight of board, CM1: 157.9 g 340 g/157.9 g = 2.15 g/g 340 g/0.03952 m2 = 8603.24 g/m2 Notes: gamma-Butyrolacetone has CAS-number 96-48-0.	Input	Refined resource	gamma-Butyrolacetone	8603.24			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 40 g Weight of board, CM1: 157.9 g 40 g/157.9g = 0.25 g/g 40 g/0.03952 m2 = 1012.15 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	H2O2	1012.15			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 50 g Weight of board, CM1: 157.9 g 50 g/157.9g = 0.32 g/g 50 g/0.03952 m2 = 1265.18 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	H2SO4	1265.18			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 72.5 g (The hard metal is used as material for a mat used in connection with drill machines) Weight of board, CM1: 157.9 g 72.5 g/157.9g = 0.46 g/g 72.5 g/0.03952 m2 = 1834.51 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	Hard metal	1834.51			g	Technosphere	

Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 240 g Weight of board, CM1: 157.9 g 240 g/157.9g = 1.52 g/g 240 g/0.03952 m2 = 6072.87 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	Hydrochloric acid	6072.87			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 7.9 g (Specified as Probimer which is a solder mask consisting of lacquer. Chemically the lacquer most probably is polyurethane lacquers based on acrylic resins) Weight of board, CM1: 157.9 g 7.9 g/157.9g = 0.05 g/g 7.9 g/0.03952 m2 = 199.9 g/m2 CM2: 9.24 g (specified as soldermask) Weight of board, CM2: 160.59 g 9.24 g/160.59 = 0.057 g/g 9.24 g/0.03952 m2 = 233.8 g/m2 Both boards have surface: 0,03952 m2 MASS, (CM1+CM2)/2 = 0.053 g/g SURFACE, (CM1+CM2)/2 = 433.7 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	Lacquer	433.7			g	Technosphere	
Date concieved: 1994 Data type: Derived, unspecified Method: CM1: 100 g Weight of board, CM1: 157.9 g 100 g/157.9g = 0.63 g/g 100 g/0.03952 m2 = 2530.36 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	NaOH	2530.36			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.14 g (Specified as alcalic etchliquid) Weight of board, CM1: 157.9 g 0.14 g/157.9 g = 0.00089 g/g 0.14 g/0.03952 m2 = 3.54 g/m2	Input	Refined resource	NH3	3.54			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 5.9 g (Specified as very hard paper, probably Kraftliner) Weight of board, CM1: 157.9 g 5.9 g/157.9g = 0.037 g/g 5.9 g/0.03952 m2 = 149.29 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	Paper	149.29			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 2.108 g Weight of board, CM2: 160.59 g 2.108 g/160.59 g = 0.013 g/g 2.108 g/0.03952 m2 = 53.34 g/m2	Input	Refined resource	Pb	53.34			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 8.2 g (The photoresist consist of an acrylate film) Weight of board, CM1: 157.9 g 8.2 g/157.9g = 0.052 g/g 8.2 g/0.03952 m2 = 207.49 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	Photoresist	207.49			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1 g (the ''slipp''-foil is specified as the chemical Mylar. Mylar is a DuPont polyester film, http://www.dupont.com/packaging/products/films/index.html#mylar) Weight of board, CM1: 157.9 g 1 g/157.9g = 0.0063 g/g 1 g/0.03952 m2 = 25.3 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	Polyester	25.3			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 37 g (the Prepreg is probably made of carbon fibre, http://www.plastnet.se/levpln/db_form_plast/levreg_pln.html) Weight of board, CM1: 157.9 g 37 g/157.9g = 0.23 g/g 37 g/0.03952 m2 = 936.23 g/m2 The laminate consists of glass fibre armed epoxy plastic.	Input	Refined resource	Prepreg (Carbon fibre)	936.23			g	Technosphere	

Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1.26 g Weight of board, CM1: 157.9 g 1.26 g/157.9g = 0.008 g/g 1.26 g/0.03952 m2 = 31.88 g/m2 CM2: 3.162 g Weight of board, CM2: 160.59 g 3.162 g/160.59 = 0.02 g/g 3.162 g/0.03952 m2 = 80 g/m2 Both boards have surface: 0,03952 m2 MASS, (CM1+CM2)/2 = 0.014 g/g SURFACE, (CM1+CM2)/2 = 55.94 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	Sn	55.94			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 10.4 g Weight of board, CM1: 157.9 g 10.4 g/157.9g = 0.066 g/g 10.4 g/0.03952 m2 = 263.16 g/m2 One can choose which model one like, surface or mass.	Input	Refined resource	Solder	263.16			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.629 g Weight of board, CM1: 157.9 g 0.629 g/157.9 g = 0.00398 g/g 0.629 g/0.03952 m2 = 15.91 g/m2 One can choose which model one like, surface or mass. Notes: 1-Methoxy-2-propanol Acetate has CAS-number 108-65-6	Output	Emission	1-Methoxy-2-propanol Acetate	15.91			g	Air	
Date concieved: 1998-12-16 Data type: Derived, unspecified Method: CM1: 0.752 g Weight of board, CM1: 157.9 g 0.752 g/157.9g = 0.0048 g/g 0.752 g/0.03952 m2 = 19.03 g/m2 One can choose which model one like, surface or mass. Notes: 2-Butoxy ethanol has CAS-number 111-76-2	Output	Emission	2-Butoxy ethanol	19.03			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 10.316 g Weight of board, CM1: 157.9 g 10.316 g/157.9g = 0.065 g/g 10.316 g/0.03952 m2 = 261.03 g/m2 One can choose which model one like, surface or mass.	Output	Emission	CODCr	261.03			g	Water	
Date concieved: 1998-12-16 Data type: Derived, unspecified Method: CM1: 0.01421 g Weight of board, CM1: 157.9 g 14.21 mg/157.9g = 9e-5 g/g 14.21 mg/0.03952 m2 = 0.36 g/m2 One can choose which model one like, surface or mass.	Output	Emission	Cu	0.36			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.21 mg Weight of board, CM1: 157.9 g 0.21 mg/157.9g = 1.33e-6 g/g 0.21 mg/0.03952 m2 = 0.0053 g/m2 One can choose which model one like, surface or mass.	Output	Emission	Ni	0.0053			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.177 g Weight of board, CM1: 157.9 g 0.177 g/157.9g = 0.00112 g/g 0.177 g/0.03952 m2 = 4.48 g/m2 One can choose which model one like, surface or mass. Notes: Propylene Glycol Monomethyl Ether has CAS-number 107-98-2	Output	Emission	Propylene Glycol Monomethyl Ether	4.48			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.89 mg Weight of board, CM1: 157.9 g 0.89 mg/157.9g = 5.6e-6 g/g 0.89 mg/0.03952 m2 = 0.022 g/m2 One can choose which model one like, surface or mass.	Output	Emission	Sn	0.022			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: (57,21 + 0.111) g Weight of board, CM1: 157.9 g (57,21+ 0.111) g/157.9g = 0.36 g/g (57.21 + 0.111) g/0.03952 m2 = 1447.62 g/m2 0.111 g is released to	Output	Emission	SO42-	1447.62			g	Water	

water after internal and external purification. One can choose which model one like, surface or mass.									
Date concieved: 1999 Data type: Derived, unspecified Method: 1 m2 printed board output is the base for all figures in this model. Printed boards = Life Cycle Inventory model for production of one m2 of printed board (applicable to telecommunication equipment)	Output	Product	Printed boards	1			m2	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 16.894 g Weight of board, CM1: 157.9 g 16.894 g/157.9 g = 0.11 g/g 16.894 g/0.03952 m2 = 427.47 g/m2 One can choose which model one like, surface or mass.	Output	Residue	Acidic and alcalic bath	427.47			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.632 g Weight of board, CM1: 157.9 g 0.632 g/157.9 g = 0.004 g/g 0.632 g/0.03952 m2 = 16 g/m2 One can choose which model one like, surface or mass. Notes: Carbon, activated (7440-44-0)	Output	Residue	Carbon, activated	16			g	Technosphere	
Date concieved: 1994 Data type: Derived, unspecified Method: CM1: 0.242 g (also waste consisting of ink) Weight of board, CM1: 157.9 g 0.242 g = 0.0015 g/g 0.242 g/0.03952 m2 = 6.12 g/m2 One can choose which model one like, surface or mass.	Output	Residue	Lacquer	6.12			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 18 g (Waste output include organic solvents and sludge from photoresist) Weight of board, CM1: 157.9 g 18 g/157.9 g = 0.11 g/g 18 g/0.03952 m2 = 455.46 g/m2 One can choose which model one like, surface or mass.	Output	Residue	Sludge	455.46			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 52.789 g (This waste consists of industrial waste and common household waste) Weight of board, CM1: 157.9 g 52.789 g/157.9 g = 0.33 g/g 52.798 g/0.03952 m2 = 1335.75 g/m2 One can choose which model one like, surface or mass.	Output	Residue	Waste, other	1335.75			g	Technosphere	

About Inventory

Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is;

	- to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a printed board manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of printed boards in our telecom products. The usage for this set of data are life cycle assessments where printed boards of different kinds are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. --- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to printed boards in electronic equipment if you know the area of the printed boards. -- Transports.-- Here follows a more detailed description of transports of materials and components to the respective manufacturer factories. These transports are not included in the model.

The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturer. This gives the average transportation by each mode of transport.

-- Truck transportation: --

Component manufacturer one (CM1):

Weight of component: 157.91 g

Copper pellets with weight 20 g is transported 3 km by road i.e. 20 g*3 km, Tin 1.26 g*3 km, Solder 10.4 g*10 km, Photoresist 4.1 g* 1500 km and 4.1 g * 960 km, Paper 5.9 g*400 km, Slip foil 1 g*200 km, Laminate 86.2 g*400 km, Prepreg 37 g*400 km, Copper foil 14.3 g*400 km, Aluminium 0.16 g*30 km, Drill mat 72.5 g*200 km, HCl 240 g*400 km, H_2SO_4 50 g*400 km, H_2O_2 40 g*400 km, NaOH 100 g*400 km, Alcalic etchfluid 140 g*400 km, Probimer laquer 7,9 g*900 km, Aqua flux 10 g*10 km, Aqua oil 20 g*10 km, $FeCl_3$ 20 g*10 km, $Ca(OH)_2$ 40 g*120 km and Gammabutyrolactone 340 g*200 km.

The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives:

392868.58 gkm/157.91 g = 2487 gkm/g
392868.58 gkm/0.03952 m2 = 9.94e6 gkm/m2 = 9.94 ton*km/m2

Component manufacturer two (CM2):

Weight of component: 160.59 g

FR4 (laminate) with weight 50 g is transported 200 km by road i.e. 50 g*200 km, Base material copper 50 g*200 km, Galvanic copper 47 g*200 km, Sn/Pb 5.27 g*100 km and Soldermask 8.32 g*500 km.

The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives:

34087 gkm/160.59 g = 212.26 gkm/g
34087 gkm/0.03952 g = 862.52e3 gkm/m2

This gives the average total transportation work by truck for CM1 and CM2:

MASS, (CM1+CM2)/2= 1349.63 gkm/g
SURFACE, (CM1+CM2)/2= 5.4e6 gkm/m2

-- Boat transportation: --

Component manufacturer one (CM1):

Weight of component: 157.91 g

Photoresist with weight 4.1 g is transported 250 km by boat, i.e. 4.1 * 250 km, 4.1 g * 1250 km, Alcalic etchfluid 140 g*400 km and Probimer laquer 7,9 g*900 km.

The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives:

356.94e3 gkm/157.91 g = 2260.4 gkm/g
356.94e3 gkm/0.03952 m2 = 9e6 gkm/m2

About Data

The data is based on information from one Swedish manufacturer and one Italian. The information was gathered using a life cycle inventory questionnaire.

All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model.

Of the flows about little more than 84 % are not average values. The flows for Raw material input of FR4 laminate, Copper, Lacquer, Sn and Pb are average values.

In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included.

The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so.

16 % of the flows stated by CM1 and CM2 have been just measured, 53 % of the flows have just been calculated, 13 % estimated and 18 % first measured and then calculated. CM1 have not stated any information about the flows.

In specific QmetaData we have indicated specifically for each flow how many manufacturers have been included for each flow.

The outline of the LCI data questionnaire that were used in the inventory follows below. No limitations or specifications were set for which substances they had to account

	-- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes.´ Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gatherd it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Printing works

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Printing works
Functional Unit	ton
Functional Unit Explanation	1 ton printed matter (paper)

Process Type	Gate to gate
Site	Elanders Wezäta AB Box 5057 402 22 Göteborg Sweden
Sector	Consumer goods
Owner	Elanders Wezäta AB Box 5057 402 22 Göteborg Sweden
Technical system description	The company runs printing enterprise. The plant consists of three departments, paper printing, media printing and electrical/mechanical workshop. A detalied description of the different departments follows below: Paper printing There are four rulloffsetpresses, three heatsetpresses, paper storage and workshops in the department. Two of the rulloffsetpresses have the size of eight A4 pages. The other two have the size of sixteen A4 pages. The paper is continously fed into the rolloffpress from a roller. The paper passes throught a couple of printing mechanisms, each applying one colour. The print is then dryed in an oven, cooled, cut and folded into the final product. Contaminations from solvents in the air, led from the rulloffsetpresses, are removed in a catalytic oxidation plant (Haldor Topsöe, of Regenox type), with 97% cleaning efficiency. The cleansed air is emitted through a smoke-stack 14 meters above ground. The air from the oven contains solvents and is therefore led to a thermal combustion plant (MEG-Therm), with 90% cleaning efficiency. The cleansed air is emitted through a smoke-stack 11 meters above ground. The rollers are cleansed with organic solvents. In three of the rolloffsetpresses the cleansing is done automatically and in the fourth manually. Media printing The department has manual and electric repro- and composing equipment, and a Misomex plate copying machine. The company use graphic material as film, developer and fixing-bath. At the department there is also equipment for test printing and a coal filter which reduces the emission of organic solvents. The equipment used is 2 pce Scanner Crosfield used for separating colours 1 pcs Misomex, plate copying machine 1 pcs Scitex assembler used for putting text and pictures together 4 pcs film developers 1 pcs filmutkörare Electrical/mechanical workshop In the workshops mostly service- and repairing work is done. The equipment used are for example lathes, cutters, drilling-machines and some welding units. Alkaline cleaners are used. Water is taken from the pipeline of the local water purification plant, and the waste water is led to the sewage treatment works. The surface water is led to Mölndalsån.

System Boundaries	
Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires. Measurements have been done regarding emissions of CO_2 and NOx but an amount per ton printed paper can not be calculated from the information in the environmental report. For more information about the emissions see''about data''.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	The company states that they use district heating, but is not able to account for how much. The environmental report states that the company has some industrial waste, consisting of scrap-steel, wood and refuse, but they are not able to account for the amount The scrap-steel is recycled by Stena Metall Återvinning AB. The wood is splintered at Sävenäs. The refuse is combustioned at Sävenäs sopförbränning.
Allocations	

Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	See LitteratureRef.
Method	Study of the Environmental Report for 1996 The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1996, which was 4100 ton printed paper. The laboratory company used are ÅF-IPK and Halder Topsöe A/S
Literature Reference	- ''Environmental Profile Report for the European Aluminium Industry'', European Aluminium Association, April 2000. - Bauxite mining: BUWAL Environmental series no. 132 (1991), IPAI Bauxite Mine survey, other sources - Limestone production: I. Fecker, EMPA (1989), BUWAL Environmental series no. 132 (1991), Pechiney (1994), VAW (1994) - Caustic soda production: I.Boustead. Ecoprofiles of plastics and related intermediates, APME Brussels (1999) - Aluminium fuoride production: Norzinc/Alufluor/Pechiney (1994) - Petrol coke production: Pechiney (1994), APME report no.2 (1995), Statoil (Norway, 1995) - Pitch production: Hoogovens Staal, note 21 November 1997 - SAEFL Environmental Series 250 (1998) ''Buwal 250'' - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems - Electricity used in Russian primary aluminium production is taken from a report by J. Schäfer (GDA, 1998)
Notes	The data type unspecified implies that one does not know the origin of the data. Flow of substances It is not possible to specify the sources of each emission, but here are some information about the flows of the substances. Is bound in the product: A Magnusson 20-575 A Magnusson 10-303W A Magnusson 389-2000 Elektromek Inc (partly) Kodak Signature (partly) Paint (partly) Schneidler, 3M Spraymount (partly) Nordic, Wet 86 Emitted to air: Elektromek Inc (partly) Schneidler, 3M Spraymount (partly) Nordic, Novaren 10 (partly) Ethyl acetate (partly) MB Sweda, Asol (partly) Recycled when rags are washed: Nordic Novaren 10 (partly) Ethyl acetate (partly) MB Sweda, Asol (partly) Is combusted in the catalyst: Nordic Novaren 10 (partly) Ethyl acetate (partly) MB Sweda, Asol (partly) Emitted in the machines: Mobil 629 (partly) Mobil 425 (partly) Is recycled: Mobil 629 (partly) Mobil 425 (partly) Kodak Developer Kodak Dev RA 2000 Kodak Aqua Image Kodak Fix 3000 Is gathered up in the cole filter: Kodak Signature (partly) Emitted in oven, and cleansed: Paint (partly) Is gathered up in the catalytic oxidation plant: Paint (partly)

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1996 Data type: Unspecified Notes: Consists of homopolymer and PVAc-dispersion, used as glue. Is bound in the product	Input	Refined resource	A Magnusson 10-303W	0.165853659			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consists of acryle, copolymer and dispersion, used as glue. Is bound in the product	Input	Refined resource	A Magnusson 20-575	0.214634146			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consists of oopolymer and PVAc-dispersion, used as glue. Is bound in the product	Input	Refined resource	A Magnusson 389-2000	0.658536585			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consists of scratch-off ink, paint used for printing. Is bound parly in the product and partly emitted to the air.	Input	Refined resource	Elektromek Inc	0.109756098			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Used for machine washing and cleaning. Is partly emitted to the air, partly recycled when rags are washed and partly combusted in the catalyst.	Input	Refined resource	Ethyl acetate	0.99804878			kg	Technosphere	

Date concieved: 1996 Data type: Unspecified Notes: Used as gumming. Is recycled.	Input	Refined resource	Kodak Aqua image	0.043902439			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Used as film developer. Is recycled	Input	Refined resource	Kodak Dev RA 2000	0.12195122			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consists of sodiumoctylsulphate, used as plate developer. Is recycled	Input	Refined resource	Kodak Developer	0.13902439			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Used as fix. Is recycled.	Input	Refined resource	Kodak Fix 3000	0.12195122			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: 5,96% consist of petrolum distillate pigment used for paint. 94,0% consist of petrolium distillate used in dispersion Is partly bound in the product and partly gathered up in the carbon filter	Input	Refined resource	Kodak Signature	0.175853659			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consist of polydimethyl siloxan, used as lubricant, silicon and anti-smudge agent.	Input	Refined resource	Malmsten/Bergwall E1P	0.384146341			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consists of white (petroleum) spirit, used for machine washing and cleaning. Is partly emitted to the air, partly recycled when rags are washed and partly combusted in the catalyst.	Input	Refined resource	MB Sweda, Asol	0.365609756			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consists of mineral oil, used as lubricate. Is partly emitted in the machines and partly recycled.	Input	Refined resource	Mobil, 425	0.097560976			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consists of mineral oil, used as lubricate. Is partly emitted in the machines and partly recycled.	Input	Refined resource	Mobil, 629	0.182926829			l	Technosphere	
Date concieved: 1996 Data type: Unspecified	Input	Refined resource	Natural gas	45.09219512			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consists of petroliumnaphta, used for machine washing and cleaning. Is partly emitted to the air, partly recycled when rags are washed and partly combusted in the catalyst.	Input	Refined resource	Nordic, Novaren 10	0.585365854			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consists of sodium phosphate and sodium citrate, changes pH and surface tension. Is bound in the product	Input	Refined resource	Nordic, Wet 86	0.780487805			l	Technosphere	

Date concieved: 1996 Data type: Unspecified Notes: Consists of mineral oils and pigment, used for printing. Is partly bound in the product, partly emitted in the oven and cleansed and partly gathered up in the catalytic oxidation plant.	Input	Refined resource	Paint	13.75609756			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Used as glue (spray). Is partly bound in the product and partly emitted to the air.	Input	Refined resource	Schneidler, 3M Spraymount	0.001219512			l	Technosphere	
Date concieved: 1996-10-07 Data type: Unspecified Method: The amount in the table has been calculated from values from the environmental report regarding the Ag contents per liter waste water from the developers, how many films that are developed and the amount of waste water from every film developed. Notes: The rinsing water from the developing is contaminated with Ag. The three developing machines gave the following contributions to the contamination during 1996 : Dupont 5,63% Kodak 58,6% Plate developer 35,7%	Output	Emission	Ag	0.216268293			mg	Water	
Date concieved: 1996 Data type: Estimated Method: The hydrocarbon amounts were measured during 24 hours, and knowing this an estimation for the whole year has been done. It is based on the following assumption about the hours the plants have been in operation: catalyst 16 h / day, 5 days/week, 49 weeks/year cole filter 2 h / day, 5 days/week, 49 weeks/year general ventilation 24 h / day, 7 days/week, 52 weeks/year Another assumption that has been made is that the solvents contents on the weekends and the hollidays are the same as during the night of measuring. This assumption is probably rather on the large side, because it seems lightly that the hydrocarbon contents are lower during these periods. The approximation regarding the amount for the whole year based on measurements during just 24 hours is not very certain. The extent of the production at the time for measuring does not coinside with the average extent of production. In acount to this another approximation has to be done, which makes the estimation even more	Output	Emission	Hydrocarbon	0.00014878			tonne	Air	

uncertain. The taking and analysing of specimens is done by the company ÅF-IPK AB, Kvarnbergsgatan 2, Box 1551, 401 51 Göteborg, Sweden, Phone number +46 (0)31 7431000. The amount of total hydrocarbon is measured with a devise which detects flam ionization. The ionization causes a signal, in the detector. The signal is approximately proportiunal to the amount of carbon, which through conbustion becomes carbon dioxide. This method is commonly used, and found to be relyable. It is also one of the few that allows continuous determination of the variation of the carbon content. Different carbon combines give different signal levels, because of the carbon's bond. This gives an error to the result. The instrument gives readings in parts per million. To get the reading in mg/m3 one multiplies with the mole mass of the substance in question and devides with the number of carbon atoms in 1 m3 air. The instrument used is Bernard Atomic 3005, and it has been calibrated with a known sample. The taking of specimens were done during W23 and W50. The level of production were not the same on two occations. Also the flow of gas and its temperature were measured during these weeks, so that the concentration could be converted to an amount. The flow of gas is measured by a Pitot tube and a micromanometer. The temperature is measured by thermal converter. Notes: The emission of hydrocarbon has been measured at the catalyst (1), the cole filter (2) and the general ventilation (3). A hydrogen content has also been detected which comes from not confirmed sources (4). The different sourses make the following contributions to the contamination. 1. 16,9% 2. 4,23% 3. 76,3% 4. 2,54%									
	Output	Product	Printed paper	1			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Rags used for cleaning the rollings are sent to the Miljötvätt AB, where they are washed and then returned to Elanders Wezäta AB to be used again. There is no information about the amounts of contaminations that are washed out.	Output	Residue	Contaminated rags	9.146341463			pce	Technosphere	

Notes: 78,9% Are recycled by Stena Metall Återvinning AB.	Output	Residue	Printing plates	0.535365366			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Disposed by Stena Scanfors	Output	Residue	Unspecified	0.49149951227			kg	Technosphere	
Notes: The waste film is recycled by Stena Scanfors AB.	Output	Residue	Waste film	0.143171219			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is recycled by Stena Scanfors AB.	Output	Residue	Waste fixing	0.216829268			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Disposed by Reci Industri AB	Output	Residue	Waste glue	0.4482731708			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Also containing lubricating oil. Disposed by Reci Industri AB	Output	Residue	Waste paint	0.45307609763			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The waste paper is treated by HA Industri Göteborg AB, and is then taken to a paper-mill.	Output	Residue	Waste paper	0.391219512			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Disposed by Reci Industri AB	Output	Residue	Waste solvents	0.206525855369			kg	Technosphere	

About Inventory

Publication	Environmental report from Elanders Wezäta AB for 1996, The Board of County in Göteborg and Bohus The Environmental Administration in the municipality of Göteborg. The Environmental Administration in the municipality of Göteborg. -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden.
Practitioner	Rössum, Thor VD - Elanders Wezäta AB Grafiska vägen 22 402 22 Göteborg Sweden.
Reviewer	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden
Applicability	There is little information about what kind of prints that are made by the company. For more information contact the company.
About Data	Measurements have been done regarding emissions of CO_2 and NO_x but an amount per ton printed paper can not be calculated from the information in the environmental report. CO_2 content has been measured in the outgoing air at the catalytic oxidation plant (1) and the thermal combustion plant (2). The CO_2 content in the air was at (1) 0,54% and at (2) 1,7%, in account of the whole production. The flows at the sites were also measured and the results were at (1) 5150 m3/h and at (2) 3700 m3/h. Knowing the flow one can calculate the amount CO_2 per hour, but the total amount for 1996 is impossible to calculate, because one can not from the environmental report get the information about how many hours the plants were in operation during 1996. The CO_2 contents were measured with an IR instrument of Binos type. The range of measurement of the instrument for CO_2 is 0-20%. The instrument has been calibrated with

	a gas, which contents are known (CO2=14,9vol%). The margin of error is +/- 2%. The emission of NOx during 24 hours was at the time of taking the spiecement 2,738 g in account of the whole production that day. There is no information pointing at the fact that the extent of the production this day was characteristic for the whole year. The total amount for 1996 is impossible to calculate, because one can not, from the environmental report, get the information about how many days the thermal combustion plant was in operation during 1996. The measuring was done in the following way. Air was continuously sucked through a gas preparation system, which dryes the gas. The NOx contents was then determined by a instrument (Binos), which registrats the contents continuously. The NO is detected with IR-spectrophotometry and NO2 with UV-spectrophotometry. The range of measurement is 0-300 ppm or 0-1000 ppm for NO and 0-50 ppm or 0-150 ppm for NO2. The instrument is calibrated with calibrating gas, which has the contents 906 ppm NO and 120 ppm NO2. The margin of error is +/- 2% for air (zero gas).
Notes	

SPINE LCI dataset: Processing of waste-oil into fuel oil

Administrative	
Finished	Y
Date Completed	1998-04-17
Copyright	
Availability	public

Technical System	
Name	Processing of waste-oil into fuel oil
Functional Unit	1 m3 processed waste-oil
Functional Unit Explanation	Due to that impact caused by processing waste-oil into fuel oil is of interest. The processed oil is the company´s main product. It is sold as fuel oil, mainly to the cement industry and to power plants. Waste-oil Delivered waste-oil to Reci Halmstad: · Stockholm 19 554 m3 · Jönköping 5 839 m3 · Luleå 150 m3 · Umeå 1661 m3 · Göteborg 14 394 m3 (pre-treated) · Locally Halmstad 13 150 m3 · Emulsions totally 25 701 m3 Based on the water contents and amount delivered the waste-oil in 1 m3 of converted fuel oil origins from: · Stockholm 34 % · Jönköping 10 % · Luleå 0,26 % · Umeå 2,83 % · Göteborg 30,2 % · Halmstad 22,71 %
Process Type	Gate to gate
Site	Borg, Bengt Reci Industri AB Box 165 301 05 Halmstad
Sector	
Owner	Borg, Bengt Reci Industri AB Box 165 301 05 Halmstad

Technical system description	Waste-oil and oil emulsions are delivered to Reci's facility in Halmstad. The recieved amount fluctuates during the years. During 1997 the recieved amount of waste oil was 54 748 m3. At the facility the waste-oil is processed under the influence of heat and mechanical work. The oil is thereby purified from water and some pollution. The processed oil is sold as fuel oil, mainly to the cement industry and to power plants. Oil treatment facility The waste-oil is delivered by boat, ship or truck. It is sorted according to content and stored in cisterns. By heating of the oil, water and solid pollutant are derived. Heat to the process is delivered from an oil-fuelled boiler. The water goes into the water treatment facility and the solid pollutant sediments at the bottom of the tank (oil-sludge). If the oil contains light fractions or water that can not be separated from the oil by the influence of gravitation it is treated in a separate tank. At a temperature of 120-130ºC water and distillate is separated and the distillate is gathered in an accumulation tank. Emulsions are split up by heat and chemicals. Derived oil is treated as waste-oil and the water is treated in the internal water treatment facility. Water from the facility's drainage area is led to the water treatment facility in the surface water system. (Treatment of light fractions and emulsions are not part of the studied system) The produced oil is then, after filtration, pumped to an accumulation cistern for further transportation to a purchaser. Scrap derived from filtering is sent to Sävenäs, a waste fuelled power plant. To control the process the water content is analysed with the Karl-Fisher method. This generates a small quantity of COD-sludge. A sample is collected on each delivery. The sample is analysed respecting among other things PCB. COD-sludge and derived sludge from sedimentation in the oil tanks is transported to SAKAB for destruction. Water treatment facility The plant is divided in four main parts pre-precipitation, biological treatment, after-precipitation and UF/RO filtration. Chemicals are added during the pre-precipitation to split the incoming waste product. Oil and oil-sludge are separated before the water is pumped to tanks. The separated oil is sent to the accumulation tank and the oil-sludge is handled as above. In the tanks the water is biologically treated alternately by aerobe and anaerobe steps for twelve days. After the last step in biological treatment the water is pumped to the lamella separator where the clusters are separated. The water is then sent to the UF/RO part, where the water is filtrated through an ultra filter and treated with inverted osmoses. The filters are cleansed with acid- and alkaline detergents, which dissolves among other things salts. The rejected wastewater is pumped back to be sent through the UF/RO part again. The treated water is led to the nearest recipient, the Halmstad harbour. The quantity of outflow is measured and the emissions controlled according to Swedish standard. The accumulated clusters from the water treatment process are send to Reci's facility at Skarvik in Göteborg. The waste, named water-sludge, is de-watered and deposited at Torsviken in Göteborg.

System Boundaries	
Nature Boundary	Resources that are not seen as limited in Sweden are neglected e.g. land usage and fresh water. The electricity utilised by the system is only seen as a resource and the origin is not interpreted. The company is legislated to measure the following emissions: COD BOD-7 Sulphid Phenol Oil Cd Pb Cr Zn Ni
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary for the converting of waste-oil is set to Sweden.
Other Boundaries	Emissions caused by treating oil- and water-sludge are not accounted for at Reci Halmstad as this is done at external plants. The phosphoric acid and the NaOH are supposed to leave with the water-sludge and are therefore not estimated as emissions at Reci Halmstad. The de-greasing agent leaves with

	the oil sludge, combusted at SAKAB, and is therefore not estimated as an emission at Reci Halmstad. The impact caused by the substances should though be taken under consideration when treated at Reci Göteborg and SAKAB. The amount of metals in the chemical Alpoclar 200 is so low that their impact per functional unit is neglected. No measurable emission from the cisterns to the air has occurred. · No spill occurs in the plants. · The loading and unloading step is neglected in terms of consuming resources or emitting outputs. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected.
Allocations	The plant treats both waste-oil and emulsions so the emissions had to be allocated. Emissions are allocated according to the relative oil content of the substance. This approach is conducted as the pollutants are believed to origin from the oil. The waste-oil generally contains 70 % oil and the emulsions about 5 %. This means that the waste oil contributes with 70 % oil of total amount received and the emulsions with 5 % of total amount emulsions received. Thereby is waste-oil contributing with 96.9% to the total amount of the extracted oil, and should be accounted for this amount of the total emissions. This is calculated as follows: Waste-oil Amount received: 40 354 m3 Oil contents: 70% Pre-treated waste-oil Amount received: 14 394 m3 Oil contents: 85 % Emulsion Amount received: 25 701 m3 Oil contents: 5 % (40 354*0,70+14 394*0,85)/(40 354*0.70+14 394*0,85+25 701*0,05)=0,969
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Unspecified
Represents	See LitteratureRef.
Method	Study of the environmental report of 1997 for Reci's plant in Halmstad and inquires of the employees. The subtances are divided with the total production of converted fuel oil, 36 604 m3 in 1997, from waste-oil to represent the amount per functional unit.
Literature Reference	- ''Environmental Profile Report for the European Aluminium Industry'', European Aluminium Association, April 2000. - Bauxite mining: BUWAL Environmental series no. 132 (1991), IPAI Bauxite Mine survey, other sources - Limestone production: I. Fecker, EMPA (1989), BUWAL Environmental series no. 132 (1991), Pechiney (1994), VAW (1994) - Caustic soda production: I.Boustead. Ecoprofiles of plastics and related intermediates, APME Brussels (1999) - Aluminium fuoride production: Norzinc/Alufluor/Pechiney (1994) - Petrol coke production: Pechiney (1994), APME report no.2 (1995), Statoil (Norway, 1995) - Pitch production: Hoogovens Staal, note 21 November 1997 - SAEFL Environmental Series 250 (1998) ''Buwal 250'' - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems - Electricity used in Russian primary aluminium production is taken from a report by J. Schäfer (GDA, 1998)
Notes	The data type unspecified implies that one does not know the origin of the data. Flow of substances It is not possible to specify the sources of each emission, but here are some information about the flows of the substances. Is bound in the product: A Magnusson 20-575 A Magnusson 10-303W A Magnusson 389-2000 Elektromek Inc (partly) Kodak Signature (partly) Paint (partly) Schneidler, 3M Spraymount (partly) Nordic, Wet 86 Emitted to air: Elektromek Inc (partly) Schneidler, 3M Spraymount (partly) Nordic, Novaren 10 (partly) Ethyl acetate (partly) MB Sweda, Asol (partly) Recycled when rags are washed: Nordic Novaren 10 (partly) Ethyl acetate (partly) MB Sweda, Asol (partly) Is combusted in the catalyst: Nordic Novaren 10 (partly) Ethyl acetate (partly) MB Sweda, Asol (partly) Emitted in the machines: Mobil 629 (partly) Mobil 425 (partly) Is recycled: Mobil 629 (partly) Mobil 425 (partly) Kodak Developer Kodak Dev RA 2000 Kodak Aqua Image Kodak Fix 3000 Is gathered up in the cole filter: Kodak Signature (partly) Emitted in oven, and cleansed: Paint (partly) Is gathered up in the catalytic oxidation plant: Paint (partly)

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geograp
Date concieved: 1997 Data type: Economical information Method: Total amount used 10044 kg. Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for Alpoclar 200 from MB-Sveda AB. Notes: Alpoclar200 (polyaluminium chloride) is used in the pre-precipitation step at the water treatment facility. The chemical is supposed to leave with the treated water. Salesman: MB-Sveda Ltd Box 4072 203 11 Malmö Phone: +46 -40 35 28 00 Content: Water 60-70% Assay Al203 17-18 wt% Cl 21-22 wt% S04 1,0-1,5 wt% Sb 0,1 ppm (max) As 0,1 ppm (max) Cd 1,0 ppm (max) Cr 2,0 ppm (max) Cu 1,0 ppm (max) Pb 1,0 ppm (max) Fe 75,0 ppm (max) Mn 5,0 ppm (max) Hg 0,1 ppm (max) Ni 5,0 ppm (max) Zn 5,0 ppm (max) Se 0,5 ppm (max)	Input	Refined resource	Alpoclar 200	0.2744			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Totally was 2040 litres used. Literature: Environmental report of 1997 for Reci Industri Halmstad. Product information from Skandinaviska oljecentralen. Notes: The degreasing agent (Kallavfettningsmedel) is used to clean the tanks. It leaves with the derived oil sludge. Salesman: Skandinaviska Oljecentralen Stillefors 55614 Jönköping Sweden Phone: +46 -36 18 60 60 Content: Naphta 95-100% Oleylaminetoxilat 0,1-1,0% Dipropylenglykolmetyleter 0,1-1,0%	Input	Refined resource	Degreasing agents	0.0557			l	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Electricity. Total usage 2878 MWh. Literature: Environmental report of 1997 for Reci Industri Halmstad	Input	Refined resource	Electricity	78.62			kWh	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: 1559 m3 fuel oil (Eldningsolja 4) has been used. Literature: Environmental report of 1997 for Reci Industri Halmstad Notes: The fuel oil is used in oil-fuelled boiler to heat up the waste-oil and emulsions.	Input	Refined resource	Fuel oil	0.0426			m3	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: 9048 kg was used in 1997. Literature: Environmental report of 1997 for Reci Industri Halmstad Notes: HCl (30%) is used as a detergent when the filters are cleaned in the UF/RO facility. It	Input	Refined resource	HCl	0.2472			kg	Technosphere	Sweden

is supposed to leave with the treated water.									
Date concieved: 1997 Data type: Economical information Method: Totally 98629 kg used. Literature: Environmental report of 1997 for Reci Industri Halmstad Notes: NaOH is used to adjust the pH-level in the biological treatment step at the water treatment facility. It is supposed to leave with the water sludge.	Input	Refined resource	NaOH	2.694			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Totally 1077 kg used Literature: Environmental report of 1997 for Reci Industri Halmstad Notes: Nitric acid, HNO3, is used as a detergent when cleaning the filters at the UF/RO facility. It is supposed to leave with the treated water.	Input	Refined resource	Nitric acid	0.0294			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Totally where 7255 kg used. Literature: Environmental report of 1997 for Reci Industri Halmstad Notes: Phosphoric acid (75%). The acid is used in the biological treatment of the wastewater as nutritive salt. The phosphoric acid is supposed to leave with the water sludge.	Input	Refined resource	Phosphoric acid	0.1982			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Total amount used 56356 kg. Literature: Environmental report of 1997 for Reci Industri Halmstad. Product information for PIX 111 from Wretman & Söner AB. Notes: PIX 111 (FeCl-solution) is used in the pre-precipitation step at the water treatment facility. The chemical is supposed to leave with the treated water. Salesman: Wretman & Söner Ltd Box 2040 183 02 Täby Content: Fe(III) 13,7 +/-0,2 % Cl 26-28%	Input	Refined resource	PIX 111	1.540			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Unspecified, guesstimate Method: Total amount used 263 kg. Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for Sedipur CF 104 from MB-Sveda AB Notes: The polymer, Sedipur Cf 104, is used in the pre-precipitation step at the water treatment facility. The polymer is very soluble in water and is therefore supposed to leave with the water. Salesman: MB-Sveda AB Box 4072 203 11 Malmö Phone: +46 -40 35 28 00 Content: Akrylamid <0,1%	Input	Refined resource	Sedipur Cf 104	0.0070			kg	Technosphere	Sweden

Dimetylaminoakrylat unspecified amount. The akrylamid is very biologically decomposeable (Oecd-test 301C: 73% after 14 days). Since it takes about 12 days for the water to leave the biological part of the water treatment facility, no akrylamid is supposed to be measurable in the outflowing water. As the amount of dimetylaminoakrylat is unspecified and no other subtances are presented, Sepidur Cf 104 is supposed to contain up to 100% of dimetylaminoakrylat.									
Date concieved: 1997 Data type: Economical information Method: Total amount used 150 litre. Literature: Environmental report of 1997 for Reci Industri Halmstad Notes: Natriumhypoklorit (Swedish name) is used as a detergent when cleaning the filters at the UF/RO facility. It is supposed to leave with the treated water.	Input	Refined resource	Sodiumhypoclorite	0.0041			l	Technosphere	Sweden
Date concieved: 1997 Method: Totally where 2080 litre used during 1997. Used transfer oil is treated as waste-oil. Literature: Environmental report of 1997 for Reci Industri Halmstad. Bengt Borg production manager Reci Industri Halmstad. Notes: The transfer oil (Mobiltherm 605) is used to transfer heat from the powerplant to the tanks where oil and emulsions are heated.	Input	Refined resource	Transformer oil	0.0568			l	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Total amount used 2700 litre. Literature: Environmental report of 1997 for Reci Industri Halmstad. Product information about TUFF 100 from Westlund processteknisk AB Notes: Alkaline detergent,TUFF 100, is used in the cleaning of the UF/RO filters. It is supposed to leave with the treated water. Salesman: Westlund processteknisk AB Vargmötesvägen 20 186 30 Vallentuna Sweden Phone: +46 -8 511 763 50 Content: Ka-lye 20-25 % Na-glukonat 4-7 % NTA-solution(48%) 3-5 % Tridecylalkoholetoxilat 10-15 % Na-kaprylaminodipropionat 1-5 %	Input	Refined resource	TUFF 100	0.074			l	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: The amount recieved is measured when pumped to the reception tanks. Total amount received; 54 748 m3. the water content is approximately at an average of 30%. Literature: Environmental report of 1997 for Reci Industri Halmstad Bengt Borg	Input	Refined resource	Waste oil	1.483			m3	Technosphere	Sweden

production manager Reci Industri Halmstad.									
Date concieved: 1997 Data type: Calculated Method: According to the ''Combustion of oil'' report in SPINE 0,007 g ashes per MJ fuel oil is emitted. The fuel oil used at Halmstad has 41 MJ/kg 950 kg/m3. (Anders Edholm) Total amount fuel oil used is 1559 m3. (Environmental report) This brings the total amount of emitted ashes to about 425 kg. Literature: ''Combustion of oil'' SPINE-report. Environmental report of 1997 for Reci Industri Halmstad. Emission calculations for Eo4 by Anders Edholm Reci Industri AB. Notes: Emitted with the unpurified fumes from the combustion of oil.	Output	Emission	Ashes	11.61			g	Air	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on the resource use. As the value was presented as an interval in the product information, a geometrical average has been chosen. Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for Alpoclar 200 from MB-Sveda AB. Notes: Assay Al204 chemical in Alpoclar 200 The content of Alpoclar 200 is stated abowe, where it is regarded to as an resource inflow.	Output	Emission	Assay Al 204	0.048			kg	Ocean	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: A sample proportional to the flow is taken once a month. This is done according to the SIS-standard SS 02 81 52.(Control program) The average value of Cd in the treated water was 0,0005 mg/l. The maximum value was 0,0012 mg/l. Total outflow of water was 43 169 m3 during the year. Total amount of Cd was aproximately 0,014 kg. (Environmental report) Literature: Environmental report of 1997 for Reci Industri Halmstad. Control program for Reci Industri Halmstad. Notes: Leaves with the outflow of treated water into the harbour basin.	Output	Emission	Cd	0.0004			g	Ocean	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on the resource use. As the values was presented as intervals in the product information, geometrical averages has been chosen. Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for Alpoclar 200 from MB-Sveda AB. Product information for PIX 111 from Wretman & Söner AB. Notes: Cl substance in Alpoclar 200 and PIX 111. The contents of Alpoclar 200 and PIX11 are	Output	Emission	Cl	474.69			g	Ocean	Sweden

stated above, where they are regarded to as resource inflows.									
Date concieved: 1997 Data type: Calculated Method: Some carbon in the fuel oil is supposed to emit as CO Amount of carbon: 950 kg/m3 87,1 weight% 827,45 kg C/m3 (Anders Edholm) Oil consumed: 1559 m3 (Environmental report) According to a report in SPINE ''Combustion of oil'' carbon is emitted as HC 0,013 g/MJ CO2 75,8 g/MJ CO 0,013 g/MJ. Based on the molar weight and the assumption that hydrocarbons have a neclectable amount of hydrogen (weight percentage), some 0,0269% of the total amount of carbon will emit as CO. This brings the total emission of CO to about 810 kg/year. Literature: Environmental report of 1997 for Reci Industri Halmstad. ''Combustion of oil'' report in SPINE Emission calculations for Eo4 by Anders Edholm Reci Industri AB. Notes: Emitted with the unpurified fumes from the internal power plant.	Output	Emission	CO	22.12			g	Air	Sweden
Date concieved: 1997 Data type: Calculated Method: Amount of carbon: 950 kg/m3 87,1 weight% 827,45 kg C/m3 (Anders Edholm) Oil consumed: 1559 m3 (Environmental report) According to a report in SPINE ''Combustion of oil'' carbon is emitted as HC 0,013 g/MJ CO2 75,8 g/MJ CO 0,013 g/MJ. Based on the molar weight and the assumption that hydrocarbons have a neclectable amount of hydrogen (weight percentage), some 99,9467 % of the total amount of carbon will emit as CO2. This brings the total emission of CO2 to about 4727930 kg/year. Total amount CO2 emitted 4730 tonnes. Literature: Environmental report of 1997 for Reci Industri Halmstad. ''Combustion of oil'' report in SPINE Emission calculations for Eo4 by Anders Edholm Reci Industri AB. Notes: Emitted with the unpurified fumes from the oil-fuelled boiler.	Output	Emission	CO2	129.16			kg	Air	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: A sample proportional to the flow is taken once a week This is done according to the SIS-standard SS 02 81 42. (Control program) The average value of COD in the treated water was 500 mg/l. The maximum value was 567 mg/l and the minimum 418 mg/l. Total outflow of water was 43 169 m3 during the year. Total amount of COD was 42400 kg. (Environmental report) Literature: Environmental report of 1997 for Reci Industri	Output	Emission	COD	1158.3			g	Ocean	Sweden

Halmstad. Control program for Reci Industri Halmstad. Notes: Leaves with the outflow of treated water into the harbour basin.									
Date concieved: 1997 Data type: Monitored data, discrete Method: A sample proportional to the flow is taken once a month. This is done according to the SIS-standard SS 02 81 52. (Control program) The average value of Cr in the treated water was <0,002 mg/l. Total outflow of water was 43 169 m3 during the year. Total amount of Cr was approximately 0,26 kg. (Environmental report) Literature: Environmental report of 1997 for Reci Industri Halmstad. Control program for Reci Industri Halmstad. Notes: Leaves with the outflow of treated water into the harbour basin.	Output	Emission	Cr	0.007			g	Ocean	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on the resource use. As the amount was unspecified an estimation has been made (see data for Sedipur Cf 104 above). Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for Sedipur CF 104 from MB-Sveda AB. Notes: Dimetylaminoakrylat (Swedish name) substance in Sedipur CF 104. The content of Sedipur Cf 104 is stated abowe, where it is regarded to as an resource inflow.	Output	Emission	Dimetylaminoakrylat	0.007			kg	Ocean	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on the resource use. As the value was presented as an interval in the product information, an average value has been chosen. Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for PIX 111 from Wretman & Söner AB. Notes: Fe (III) substance in PIX 111. Leaves with the treated water. The content of PIX 111 is stated abowe, where it is regarded to as an resource inflow.	Output	Emission	Fe	210.9			g	Ocean	Sweden
Date concieved: 1997 Data type: Calculated Method: Amount of carbon: 950 kg/m3 87,1 weight% 827,45 kg C/m3 (Anders Edholm) Oil consumed: 1559 m3 (Environmental report) According to a report in SPINE ''Combustion of oil'' carbon is emitted as HC 0,013 g/MJ CO2 75,8 g/MJ CO 0,013 g/MJ. Based on the molar weight and the assumption that hydrocarbons have a neclectable amount of hydrogen (weight percentage), some 0,0134 % of the total amount of carbon will emit as HC. This brings the total	Output	Emission	HC	5.11			g	Air	Sweden

emission of HC to about 187 kg/year. Literature: Environmental report of 1997 for Reci Industri Halmstad. ''Combustion of oil'' report in SPINE Emission calculations for Eo4 by Anders Edholm Reci Industri AB. Notes: Emitted with the unpurified fumes from the internal power plant.									
Date concieved: 1997 Data type: Economical information Method: Based on the resource used. Literature: The environmental report of 1997 for Reci Industri Halmstad. Notes: See above HCl resource.	Output	Emission	HCl	74.15			g	Ocean	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on the resource use. As the value was presented as an interval in the product information, an average value has been chosen. Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for TUFF 100 from Westlund processteknik AB. Notes: KOH chemical in TUFF 100, leaves with the outflowing water. The content of TUFF 100 is stated abowe, where it is regarded to as an resource inflow.	Output	Emission	KOH	0.0166			l	Ocean	Sweden
Date concieved: 1997 Data type: Economical information Method: Based on the resource use. Literature: The environmental report of 1997 for Reci Industri Halmstad. Notes: Natriumhypoclorit (NaClO) leaves with the treated water. Supposed to be relative harmless since it can be used to disinfect food products or be used in swimming-pools.	Output	Emission	NaClO	0.004			l	Ocean	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: A sample proportional to the flow is taken once a month. This is done according to the SIS-standard SS 02 81 52. (Control program) The average value of Ni in the treated water was 0,05 mg/l. The maximum value was 0,055 mg/l and the minimum 0,017 mg/l. Total outflow of water was 43 169 m3 during the year. Total amount of Ni was 7,12 kg. (Environmental report) Literature: Environmental report of 1997 for Reci Industri Halmstad. Control program for Reci Industri Hamstad. Notes: Leaves with the outflow of treated water into the harbour basin.	Output	Emission	Ni	0.1945			g	Ocean	Sweden
Date concieved: 1997 Data type: Economical information Method: Based on the resource	Output	Emission	Nitric acid	29.42			g	Ocean	Sweden

used. Literature: The environmental report of 1997 for Reci Industri Halmstad. Notes: HNO3 see above Nitric acid, resource.									
Date concieved: 1997 Data type: Calculated Method: According to a report from Studsvik ''NOx-utsläpp från oljeeldade pannor'' (Studsvik/E2-80/91) the emission is approximately 130 mg/MJ for Eldningsolja 4. Density: 950 kg/m3 Calorific equivalent: 41 MJ/kg Amount of energy supplied: 950*41 = 38950 MJ/m3 Amount of emitted NOx: 38950*130 = 5,06 kg/m3 (Anders Edholm) Oil consumed: 1559 m3. (Environmental report) Total amount NOx emitted 7884,54 kg. Literature: Environmental report of 1997 for Reci Industri Halmstad. Emission calculations for Eo4 by Anders Edholm Reci Industri AB. Notes: Emitted with the unpurified fumes from the oil-fuelled boiler.	Output	Emission	NOx	215.51			g	Air	Sweden
Data type: Calculated Method: Based on the resource use. As the value was presented as an interval in the product information, an average value has been chosen. Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for TUFF 100 from Westlund processteknik AB. Notes: Nta-solution (re-calculated to 100%) chemical in TUFF 100, leaves with the outflowing water. The content of TUFF 100 is stated abowe, where it is regarded to as an resource inflow.	Output	Emission	NTA-solution	0.0014			l	Ocean	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: A sample proportional to the flow is taken once a week This is done according to the SIS-standard SS 02 81 45. (Control program) Literature: Environmental report of 1997 for Reci Industri Halmstad. Control program for Reci Industri Halmstad Notes: Leaves with the outflow of treated water into the harbour basin. Total outflow of water was 43 169 m3 during the year. Total amount of oil in the water was 8,96 kg. (Environmental report)	Output	Emission	Oil (aq)	0.2448			g	Ocean	Sweden
Date concieved: 1997 Data type: Calculated Method: The amount of oil per litre water in the surface water system is represented in the Environmental report for Reci Industri Halmstad. The data is given as one value for every month in mg/l. To calculate the total emission of oil leaving with the surface water the amount of surface water must be known. Data about the	Output	Emission	Oil (aq)	10.23			g	Ocean	Sweden

amount of precipitation in Halmstad is taken from the report ''Växtskyddsåret 1997''. The production manager, Bengt Borg has estimated the drainage area to 500 m2. The calculated amount of oil leaving with the surface water is 374,375 g/year. Month mm mg/l mg oil precipitation (oil/water) Oct 65 1.3 42250 Nov 65 1.55* 50375 Dec 30 1.8 27000 Jan 15 1.75* 13125 Feb 90 1.7 76500 Mar 25 1.55* 19375 Apr 45 1.4 31500 May 80 0.7 28000 Jun 40 0.3 6000 Jul 110 0.7* 38500 Aug 25 0.7* 8750 Sep 60 1.1 33000 Calculation: drainage area*mm precipitation*mg/l=mg oil emitted per month Values followed by * is estimated as an average value from the two closest months. This is done when data is lacking for the specific month. Precipitation data for Oct Nov Dec is taken from 1996, but are supposed to be representative for the same period of 1997. Literature: The environmental report of 1997 for Reci Industri Halmstad. Bengt Borg, production manager Reci Industri Halmstad. The report ''Växtskyddsåret 1997 Halland Skåne Blekinge'' published by: Växtskyddscentralen Box 12 230 53 Alnarp Sweden Notes: The precipitation data is taken from a table in the report ''Växtskyddsåret''. The data may therefore contain reading errors. It is not known how or where the data has been measured. The area of drainage is a coarse estimation. No infiltration to the ground or evaporation in the drainage area is supposed to take place, all precipitation leaves as oil contaminated surface water.									
Date concieved: 1997 Data type: Calculated Method: According to the ''Combustion of oil'' report in SPINE 0,03 g particulates per MJ fuel oil is emitted (data is valid for a smaller sized installation). The fuel oil used at Halmstad has 41 MJ/kg 950 kg/m3. (Anders Edholm) Total amount fuel oil used is 1559 m3.(Environmental report) This brings the total amount of emitted particulates to about 1821,7 kg. Literature: ''Combustion of oil'' SPINE-report Emission calculations for Eo4 by Anders Edholm Reci Industri AB. Environmental report of 1997 for Reci Industri Halmstad. Notes: Emitted with the unpurified fumes from the internal power plant.	Output	Emission	Particulates	49.77			g	Air	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: A sample proportional to the flow is taken once a month. This is done according	Output	Emission	Pb	0.0019			g	Ocean	Sweden

to the SIS-standard SS 02 81 52. (Control program) The average value of Pb in the treated water was <0,002 mg/l. Total outflow of water was 43 169 m3 during the year. Total amount of Pb was 0,07 kg. (Environmental report) Literature: Environmental report of 1997 for Reci Industri Halmstad. Control program for Reci Industri Halmstad. Notes: Leaves with the outflow of treated water into the harbour basin.									
Date concieved: 1997 Data type: Monitored data, discrete Method: A sample proportional to the flow is taken once a week This is done according to the SIS-standard SS 02 81 28. (Control program) The average value of destillable phenols in the treated water was 2,2 mg/l. Total outflow of water was 43 169 m3 during the year. Total amount of destillable phenols was 42 kg. (Environmental report) Literature: Environmental report of 1997 for Reci Industri Halmstad. Control program for Reci Industri Halmstad. Notes: Leaves with the outflow of treated water into the harbour basin.	Output	Emission	Phenol	1.13			g	Ocean	Sweden
Date concieved: 1997 Data type: Calculated Method: Sulphur in the fuel oil is supposed to emit as SO2 Amount of sulphur: 950 kg/m3 <0.3 weight% S=< 2,85 kg/m3 this leads to an emission of 5,70 kg/m3 SO2. (Anders Edholm) Oil consumed: 1559 m3. (Environmental report) Total amount SO2 emitted 8886 kg. Literature: Emission calculations for Eo4 by Anders Edholm Reci Industri AB. Environmental report of 1997 for Reci Industri Halmstad. Notes: Emitted with the unpurified fumes from the oil-fuelled boiler.	Output	Emission	SO2	242.77			g	Air	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on the resource use. As the value was presented as a interval in the product information, an geometrical average has been chosen. Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for Alpoclar 200 from MB-Sveda Ltd Notes: SO4 substance in Alpoclar 200 The content of Alpoclar 200 is stated abowe, where it is regarded to as an resource inflow.	Output	Emission	SO4	3.43			g	Ocean	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on the resource use. As the value was presented as an interval in the product information, an average value has been	Output	Emission	Sodiumgluconate	0.0039			l	Ocean	Sweden

chosen. Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for TUFF 100 from Westlund processteknik AB. Notes: Natriumglukonat (Swedish name) chemical in TUFF 100, leaves with the outflowing water. The content of TUFF 100 is stated abowe, where it is regarded to as an resource inflow. Natriumglukonat is supposed to be relatively harmless as it can be found in food products.									
Date concieved: 1997 Data type: Calculated Method: Based on the resource use. Literature: The environmental report of 1997 for Reci Industri Halmstad. Product information for TUFF 100 from Westlund processteknik AB. Notes: Natriumkaprylaminodipropionat (Swedish name) chemical in TUFF 100, leaves with the outflowing water. The content of TUFF 100 is stated abowe, where it is regarded to as an resource inflow.	Output	Emission	Sodiumkaprylaminodiproponate	0.0092			l	Ocean	Sweden
Date concieved: 1997 Data type: Random samples Method: A sample test is done once a week according to the SIS-standard SS 02 81 17. (Control program) The average was less than 0,09 mg/l of treated water. The minimum value was <0,03 mg/l and the maximun value <0,35 mg/l. Total outflow of water was 43 169 m3 during the year. Total amount of sulphide was 2 kg. (Environmental report) Literature: Environmental report of 1997 for Reci Industri Halmstad. Control program for Reci Industri Halmstad. Notes: Leaves with the outflow of treated water into the harbour basin.	Output	Emission	Sulphid	0.0563			g	Ocean	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: A sample proportional to the flow is taken once a week This is done according to the SIS-standard SS 02 81 12. (Control program) Total outflow of water was 43 169 m3 during the year. Total amount of suspended materials was 3119 kg. (Environmental report) Literature: Environmental report of 1997 for Reci Industri Halmstad. Control program for Reci Industri Halmstad. Notes: Leaves with the outflow of treated water into the harbour basin.	Output	Emission	Susp solids	85.21			g	Ocean	Sweden
Data type: Calculated Method: Based on the resource use. As the value was presented as an interval in the product information, an average value has been chosen. Literature: The environmental report of 1997 for Reci Industri	Output	Emission	Tridecylalkoholetoxilat	0.009			l	Ocean	Sweden

Halmstad. Product information for TUFF 100 from Westlund processteknik AB. Notes: Tridecylalkoholetoxilat (Swedish name) chemical in TUFF 100, leaves with the outflowing water. The content of TUFF 100 is stated abowe, where it is regarded to as an resource inflow.									
Date concieved: 1997 Data type: Monitored data, discrete Method: A sample proportional to the flow is taken once a month. This is done according to the SIS-standard SS 02 81 52. The maximum value was 0,037 mg/l and the minimum <0,006 mg/l. Total outflow of water was 43 169 m3 during the year. Total amount of Zn was 2,09 kg. (Environmental report) Literature: Environmental report of 1997 for Reci Industri Halmstad. Control program for Reci Industri Halmstad. Notes: Leaves with the outflow of treated water into the harbour basin.	Output	Emission	Zn	0.057			g	Ocean	Sweden
Date concieved: 1997 Data type: Economical information Literature: Environmental report of 1997 for Reci Industri Halmstad Notes: The systems functional unit. The processed oil is sold as fuel oil, mainly to the cement industry and to power plants.	Output	Product	Converted fuel oil	1			m3	Technosphere	Sweden
Date concieved: 1997 Data type: Unspecified Method: COD-sludge originates when the water contents is analysed with Karl-Fisher. Total amount 20 kg/year. Literature: Bengt Borg production manager Reci Industri Halmstad..	Output	Residue	COD-sludge	0.0005			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Calculated Method: The amount of oil sludge that results from the processing of waste oil is calculated as 0,25% of the delivered waste oil from Stockholm and Göteborg and 0,75% of the surplus delivered. Total amount sedimentated 237,065 m3. Literature: Bengt Borg production manager, Reci Industri Halmstad. Notes: The oil sludge ,caused by sedimentation in the tanks, is derived when the tanks are cleaned. As this is not an every-year-procedure the amount sedimentated per year is estimated as above. The oil sludge is transported to SAKAB for destruction. Amount of pollutants in the oil sludge (Data from a sample taken 29/4-91) Sulphur 2,0 weight% Chloride 0,13 weight% Si 23200 mg/kg V 90 mg/kg Hg 3,5 mg/kg Al 3400 mg/kg Pb 800 mg/kg Fe 28800 mg/kg Cd <2 mg/kg Ca 4300 mg/kg Cu 1300 mg/kg Cr 400 mg/kg Ni	Output	Residue	Oil-sludge	0.0066			m3	Technosphere	Sweden

300 mg/kg Zn 5500 mg/kg The oil sludge also contains the degreasing agent Kallavfettningsmedel (see above).									
Date concieved: 1997 Data type: Unspecified, expert outspoke Literature: Bengt Borg, production manager, Reci Industri Halmstad. Notes: The scrap, derived from filtering, is transported to Sävenäs for combustion. Sävenäs is a waste fuelled power plant.	Output	Residue	Scrap	0.00026			tonne	Ground	Sweden
Date concieved: 1997 Data type: Unspecified Method: Total amount 501 m3. (Environmental report) Literature: Environmental report of 1997 for Reci Industri Halmstad. Bengt Borg production manager, Reci Industri Halmstad . Notes: Water sludge, caused by the biological step at the water treatment facility. It is transported to Reci's facility in Göteborg for de-watering and later deposition at Torsviken. Composition of the water sludge Dry substance 207 g/kg Pb 26 mg/kg Cu 120 mg/kg Cr 17 mg/kg Ni 30 mg/kg Zn 430 mg/kg Cd 0,20 mg/kg Hg <0,05 mg/kg Chloride 1300 mg/kg The data are from a sample taken 26/11-98 (Bengt Borg)	Output	Residue	Water-sludge	0.0137			m3	Technosphere	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology -- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally the result is a part of Reci's ISO 14000 certification, which acts as a guarantee to the customers. The quality of the inquiry is set due to the standards of a Master of Science thesis.
Detailed Purpose	Data about emissions from the process of converting waste-oil into fuel oil at Reci Industri Halmstad.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are specific for processing of waste oil into fuel oil. As some of the data are allocated and some are achieved through estimations and coarse measurements the result should only be seen as an estimation of the emissions.
About Data	About data for the oil contamination in the surface water: · The precipitation data is taken from a table in the report ''Växtskyddsåret''. The data may therefore contain reading errors. It is not known how or where the data has been measured. · Some values are estimated as an average value from the two closest months. This is done when data is lacking for the specific month.

	· Precipitation data for Oct Nov Dec is taken from 1996, but are supposed to be representative for the same period of 1997. · The area of drainage is a coarse estimation. · No infiltration to the ground or evaporation in the drainage area is supposed to take place, all precipitation leaves as oil contaminated surface water. The oil-sludge, caused by sedimentation in the tanks, is derived when the tanks are cleaned. As this is not an every-year-procedure the amount that sediments per year is estimated as 0,25 % of the delivered waste-oil from Stockholm and Göteborg and 0,75 % of the surplus delivered. Mass balance · Inflow about 80 634 m3 (emulsions 25 701 m3). · Outflow is approximately 80 733 m3 When calculating the mass balance 1 ton is approximated to be equal with 1 m3 for all substances. The difference between the inflow and outflow is about 0,1 per cent. When considering our approximation and possible measurement errors it is believed to be a balance in masses. Some of the data about emissions to the air from the internal power plant has been taken from the SPINE-report ''Combustion of oil''. The data are general and no difference has been made between different types of oil.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Production and assemblage of parts to the engineering industry

Administrative	
Finished	Y
Date Completed	1996-03-01
Copyright	
Availability	Public

Technical System	
Name	Production and assemblage of parts to the engineering industry
Functional Unit	1996
Functional Unit Explanation	The extent of the production is only shown in the amount operating hours (60 000) during 1996.
Process Type	Gate to gate
Site	Götaverken Motor AB Box 8843 40271 Göteborg Sweden
Sector	Machinery and equipment
Owner	Götaverken Motor AB Box 8843 40271 Göteborg Sweden
Technical system description	Götaverken Motor AB produce and assemble large and fairly large components to the engineering industry. Cleaning of components and instruments is done with alkaline cleaner. The production equipment consist of about thirty machines, as lathes, milling cutters, drilling-machines and electrical welding sets. The area of the work-shop is 6000 m2.

System Boundaries	
Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.

Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	See LitteratureRef.
Method	Study the environmental report. The amounts in the table are taken directly from the environmental report, and shows the resourses, residues and emissions for the annual production of 1996.
Literature Reference	- ''Environmental Profile Report for the European Aluminium Industry'', European Aluminium Association, April 2000. - Bauxite mining: BUWAL Environmental series no. 132 (1991), IPAI Bauxite Mine survey, other sources - Limestone production: I. Fecker, EMPA (1989), BUWAL Environmental series no. 132 (1991), Pechiney (1994), VAW (1994) - Caustic soda production: I.Boustead. Ecoprofiles of plastics and related intermediates, APME Brussels (1999) - Aluminium fuoride production: Norzinc/Alufluor/Pechiney (1994) - Petrol coke production: Pechiney (1994), APME report no.2 (1995), Statoil (Norway, 1995) - Pitch production: Hoogovens Staal, note 21 November 1997 - SAEFL Environmental Series 250 (1998) ''Buwal 250'' - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems - Electricity used in Russian primary aluminium production is taken from a report by J. Schäfer (GDA, 1998)
Notes	Götaverken Motor AB consults the following companies for waste disposal : Stena Metal Återvinning (filings and scrap) RECI (oil and emulsion) Renhållningsverket (other waste).

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Supplier is Aral.	Input	Refined resource	Deganit B 68	240			l	Technosphere	
Notes: Supplier is Aral.	Input	Refined resource	Deganit BW 220	240			l	Technosphere	
Notes: Supplier is Dinol.	Input	Refined resource	Dinitrol 112	240			l	Technosphere	
Notes: Supplier is Dinol.	Input	Refined resource	Dinol 25	180			l	Technosphere	
Notes: Supplier is Kemetyl AB.	Input	Refined resource	Methylated spirit	40			l	Technosphere	
Notes: Supplier is Mobil Oil AB	Input	Refined resource	Mobil Vactra Oil Nr.2	3600			l	Technosphere	
Notes: Supplier is Ratema	Input	Refined resource	Multi	240			l	Technosphere	
Notes: Supplier is Ratema	Input	Refined resource	Ratema Formula 400	7200			l	Technosphere	
Notes: Supplier is Bendéns/Tibnor	Input	Refined resource	Ritol	30			l	Technosphere	
Notes: Supplier is Svenska Shell	Input	Refined resource	Shell KS Fluid D	480			l	Technosphere	
Notes: Supplier is Svenska Shell	Input	Refined resource	Shell Tonna Oil TX 32	480			l	Technosphere	
Notes: Supplier is Lundvall & Co AB	Input	Refined resource	Sunnen MB-30	180			l	Technosphere	
Notes: Supplier is Texaco Marketing AB	Input	Refined resource	White Spirit	240			l	Technosphere	
Notes: Supplier is Aral	Input	Refined resource	Vitam GF 32	360			l	Technosphere	
Notes: Supplier is Aral	Input	Refined resource	Vitam GF 46	480			l	Technosphere	
Notes: Supplier is Aral	Input	Refined resource	Vitam GF 68	1200			l	Technosphere	
Notes: Transported by RECI. The values are rounded to the nearest integer.	Output	Residue	Cutting oil	49			m3	Technosphere	

	Notes: The conventionel industry waste is taken care of by the local public cleansing department. The values are rounded to the nearest integer.	Output	Residue	Industrial waste	46			tonne	Technosphere	
	Notes: Goes to Stena Metall. The values are rounded to the nearest integer.	Output	Residue	Metal filings	376			tonne	Technosphere	
	Notes: Goes to Stena Metall. The values are rounded to the nearest integer.	Output	Residue	Scrap-iron	73			tonne	Technosphere	
	Notes: Goes to Stena Metall. The values are rounded to the nearest integer.	Output	Residue	Scrap-steel	97			tonne	Technosphere	
	Notes: Transported by RECI. The values are rounded to the nearest integer.	Output	Residue	Waste oil	7			m3	Technosphere	

About Inventory

Publication	The Environmental Report from Götaverken Motor AB for 1996, The Environmental Administrationin the municipality of Göteborg. --- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Lindoff, Lennart - Götaverken Motor AB Box 8843 40271 Göteborg Sweden .
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	The extent of the production is not mentioned in the Environmental report. Because of this we have no functional unit which makes it impossible to use the data direct for life cycle analysis. Though, it is possible to get in touch with the company and try to get some more information. The function of the system and the components are not described satisfactory. For more information contact the company.
About Data	
Notes	

SPINE LCI dataset: Production and refining of metal components

Administrative

Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System

Name	Production and refining of metal components

Functional Unit	ton
Functional Unit Explanation	1 ton by the company delivered steel
Process Type	Gate to gate
Site	Oxelö Komponenter AB Arendal 418 79 Göteborg Sweden
Sector	Materials and components
Owner	Oxelö Komponenter AB Arendal 418 79 Göteborg Sweden
Technical system description	The company produces and refines metal components. The refining is done in the following steps: Rust protection: trough blasting and painting Cutting: both thermal and mechanically Shaping: Rolling and cracking Assemblage:gathering and welding

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	See LitteratureRef.
Method	Study the environmental report The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1996.
Literature Reference	The environmental report from Oxelö Komponenter AB for 1996
Notes	The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: (Gas) Used when cutting.	Input	Refined resource	Acetylene	0.000416667			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: Used as fuel for trucks. (Composition=green)	Input	Refined resource	Diesel	0.0012515			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: Used as lubricating oil	Input	Refined resource	Oil	0.0000375			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: Based on acrylic dispersion and water, used as covering paint	Input	Refined resource	Paint	0.0000604166			m3	Technosphere	

Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: Consist of ironoxide, used for rost protection	Input	Refined resource	Polyvinylbutural	0.000951667			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: (gas) Used when cuttiing.	Input	Refined resource	Propane	0.004416667			tonne	Technosphere	
	Input	Refined resource	Solvents	0.000783333			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: The steel is in the form of shots. Used when blasting and the chemical composition is 0,80-1,20% Carbon, 0,40%Silicon, 0,050% Phosphorus and 0,35-1,20% Magnese	Input	Refined resource	Steel	0.000666667			tonne	Technosphere	
	Input	Refined resource	Steel	1.333333333			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: All the solvent used is emitted to the air.	Output	Emission	Solvents	0.000783333			tonne	Air	
	Output	Product	Components of steel	1			tonne	Technosphere	
Date concieved: 1996 Data type: Economical information Method: Weighed by the waste desposal company, and specified in the invoice. Notes: Dust from blasting	Output	Residue	Dust	0.000500305			tonne	Technosphere	
Data type: Economical information Method: Weighed by the waste desposal company, and specified in the invoice. Notes: Consists mostly of plates but also a small amount scrap-metal from cutting.	Output	Residue	Scrap-metal	0.193470659			tonne	Technosphere	
Date concieved: 1996 Data type: Economical information Method: Weighed by the waste desposal company, and specified in the bill. Notes: Specified as mixed waste	Output	Residue	Waste	0.000236667			tonne	Technosphere	
Date concieved: 1996 Data type: Economical information Method: Measured by the waste desposal company, and specified in the invoice Notes: Ttransported and disposed by RECI.	Output	Residue	Waste oil	0.000125			m3	Technosphere	
Date concieved: 1996 Data type: Economical information Method: Measured by the waste desposal company, and specified in the Notes: Consists of embalage and packages	Output	Residue	Waste paper	0.001666667			m3	Technosphere	

About Inventory

Publication	The environmental report from Oxelö Komponenter AB for 1996, The Environmental Administration in the municipality of Göteborg -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --

Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Petterson, Lars - Oxelö Komponenter AB Arendal 418 79 Göteborg Sweden .
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	The funktion of the system is not very detalied and the components that are manufactured are not described. For sufficient information contact the company.
About Data	The workshop has been in operation for 225 days (8,1 h per day) and the blasting has been in operation for 60 days (4 h per day) during 1996.
Notes	

SPINE LCI dataset: Production of 0,005-0,02 mm double-rolled aluminium foil

Administrative	
Finished	Y
Date Completed	2002-05-06
Copyright	EAA
Availability	Public

Technical System	
Name	Production of 0,005-0,02 mm double-rolled aluminium foil
Functional Unit	1000 kg aluminium foil (0,005-0,02 mm)
Functional Unit Explanation	Aluminium foil with thickness between 0,005 mm and 0,02 mm.
Process Type	Gate to gate
Site	Not specified. See Geographical boundaries for further information.
Sector	Materials and components
Owner	Not specified. See Geographical boundaries for further information.
Technical system description	Aluminium foil is used in varying gauges and in a number of alloys for a variety of applications. It is available in thickness from 5 microns to 200 microns (i.e. 0,005 to 0,2 mm) and can be supplied in a range of finishes. This data set describes the production of aluminium foil in a thickness of 0,005-0,02 mm. The starting material for the production of rolled aluminium foil is aluminium slab (rolling ingot), which is first rolled into foil stock, i.e. the specific input for foil fabrication. In this documentation, the starting material is referred to as ''aluminium ingot'' when is comes from an external primary or secondary aluminium plant. It is also produced by remelting process scrap internally within this system (Ingot remelting and casting) and this input is referred to as ''casting scrap''. The included process steps are: - Aluminium foil production - 1. Sawing and scalping 2. Preheating 3. Hot rolling 4. Cold rolling foil stock 5. Cold rolling single 6. Final anneal 7. Finishing

	8. Packaging - Process scrap recycling - 9. Ingot remelting and casting Electricity production is included in the system. The process step ''Ingot remelting and casting'' is described in some further detail below. From the process steps 1-4, Sawing and scalping, Preheating, Hot rolling, and Cold rolling foil stock 643 kg scrap is going to the process step ingot remelting and casting. The process steps 5-8, Cold rolling single, Final anneal, Finishing, and Packaging contributes with additional 347 kg scrap. 44 kg scrap is recycled within the process ingot remelting and casting.

System Boundaries

Nature Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- Cut-off criteria through out this inventory is basically relevance, as checked by the industry expert team monitoring the work and confirmed by reviewer I. Boustead. As a rough guideline ''less than 1% of total mass'' is applied for the inputs, i.e if the input is less than 1% of the total mass, then it is not included in the inventory table. The base for the choices of included inventory parameters is not further described in the EAA report.
Time Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- The data derived from an industry survey from 1998 and includes literature data from reports dated 1998 and 1999.
Geographical Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- It is not always explicit in the report where the different included process steps take place. Data may be acquired from outside of Europe, e.g. regarding ancillary processes. See litterature references (LitteratureRef) next to the flow table (FlowMetaData) for further information about the data sources for each process step.
Other Boundaries	See Nature boundaries for a specification of the cut-off criteria that has been applied. The production of primary or recycled aluminium is not included in the system.
Allocations	Allocations are not explicitly specified in the Environmental Profile Report 2000.
Systems Expansions	System expansions are not explicitly specified in the Environmental Profile Report 2000.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Not relevant.
Method	PRODUCTION OF SEMI-FINISHED ALUMINIUM The data derive from an industry survey with a coverage ranging from 20% to 70%, depending on the product in question. INGOT REMELTING AND CASTING (RECYCLING OF PROCESS SCRAP) Data were obtained from aluminium-integrated cast house operations, i.e. cast houses associated with semi-finished aluminium production. The 1998 survey on semi-finished aluminium products also encompassed aluminium-integrated cast houses, with 37% coverage for the recycling of process scrap. TRANSPORTS Transport energy and air emission data have been taken from SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 ELECTRICITY For all manufacturing operations, the consumption of fossil fuels and emissions linked to electricity production was calculated according to the UCTPE 94 electrical energy model as described in BUWAL 250. Emissions from combustion only, i.e. without the precombustion contribution, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of precombustion and combustion in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, inview of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors.
Literature Reference	---Aluminium foil production and process scrap recycling Industry survey from 1998 ---Transport energy, electricity, and air emission - SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems.
Notes	In this inventory profile it is possible to identify which process step (Aluminium foil production, Process scrap recycling) the flow is connected to, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data									
QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling.	Input	Natural resource	Brown coal	233			kg	Ground	
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling.	Input	Natural resource	Crude oil	79			kg	Ground	
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling.	Input	Natural resource	Hard coal	221			kg	Ground	
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling.	Input	Natural resource	Natural gas	220			kg	Ground	
Notes: This substance is connected to the process scrap recycling. 9,5 kg is alloy additives as master alloys and 10,6 kg in pure form.	Input	Refined resource	Alloying additives	20.1			kg	Technosphere	
Notes: This substance is connected to the aluminium foil production.	Input	Refined resource	Aluminium ingot	1032			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Ar-gas	1.9			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Chlorine	0.016			kg	Technosphere	
Notes: Includes electricity produced in nuclear and hydro power plants (hydro 318 kWh and nuclear 780 kWh). This substance is connected both to the aluminium foil production and the process scrap recycling.	Input	Refined resource	Electricity	998			kWh	Technosphere	
Notes: This substance is connected to the process scrap recycling. Fluxing agents = salts.	Input	Refined resource	Fluxing agents	0.80			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Nitrogen	0.83			kg	Technosphere	
Notes: This substance is connected to the aluminium foil production. It is used for packaging.	Input	Refined resource	Paper and cardboard	0.13			kg	Technosphere	
Notes: This substance is connected to the aluminium foil production. It is used for packaging.	Input	Refined resource	Plastics	0.84			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Refractory materials	1.0			kg	Technosphere	
Notes: This substance is connected to the aluminium foil production.	Input	Refined resource	Rolling oil	41			kg	Technosphere	
Notes: This substance is connected to the aluminium foil production. It is used for packaging.	Input	Refined resource	Steel	2.4			kg	Technosphere	
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling. It is used for cooling.	Input	Refined resource	Water	124			m3	Technosphere	
Notes: This substance is connected to the aluminium foil production. It is used for packaging.	Input	Refined resource	Wood	41			kg	Technosphere	
Notes: This substance derives from the process scrap recycling.	Output	By-product	Aluminium skimmings	33			kg	Technosphere	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	CH4	3.4			kg	Air	
Notes: This substance derives from the process scrap recycling.	Output	Emission	Chlorides	0.0034			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	Chlorides	4.4			kg	Water	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	CO	0.38			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	CO2	1367			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	COD	0.006			kg	Water	

Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	Dust	1.0			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling. HC (other than CH4).	Output	Emission	HC	1.3			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	HCl	0.17			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	HF	0.015			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling. NH3 = ammonia.	Output	Emission	NH3	0.0024			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	NOx	2.4			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	Oil/grease	0.12			kg	Water	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	SO2	4.8			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	Suspended particles	0.56			kg	Water	
Notes: This substance derives from the foil production.	Output	Emission	VOC	12			kg	Air	
	Output	Product	Aluminium foil (0,005-0,02 mm)	1000			kg	Technosphere	
Notes: This substance derives from the foil production.	Output	Residue	Hazardous waste	14			kg	Technosphere	
Notes: This substance derives from the foil production.	Output	Residue	Oil	10			kg	Technosphere	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Residue	Solid waste unspecified	21			kg	Technosphere	

About Inventory

Publication	Environmental Profile Report for the European Aluminium Industry, European Aluminium Association, April 2000 -- Data documented by: Maria Erixon, IMI, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 8 May 2002 --
Intended User	LCA-practitioners.
General Purpose	The European Aluminium Association (EAA) aims to contribute to further environmental improvements in aluminium products in a life cycle concept.
Detailed Purpose	The purpose with the Environmental Profile Report 2000 is to provide LCA-practitioners with detailed and up-to-date information representing the aluminium industry activities in Europe. The purposes with formatting the Environmental Profile Report 2000 for the European Aluminium Industry to the data documentation format SPINE, according to the data documentation criteria applied at Centre for environmental assessment of Product and Material systems (CPM) are: - CPM and European Aluminium Association (EAA) are anxious to provide life cycle assessment (LCA) practitioners with accurate and up to date environmental data for aluminium production. - EAA is interested in the SPINE formatting procedure and result, as the format is a base for (and therefor somewhat similar to) the new Technical Specification in ISO, ISO 14048, regarding LCA data documentation format. - EAA is interested in the CPM data quality control and documentation criteria.
Commissioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .

Practitioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Reviewer	Dr. Ian Boustead, - 2 Black Cottages West Grinstead, Horsham GB-West Sussex RH13 7BD
Applicability	--- SPECIFIC INFORMATION FOR THIS DATA SET --- ENERGY USE IN THE DIFFERENT INCLUDED PROCESS STEPS The energy directly consumed by the operations enclosed within the system bounderies, i.e. in the various process steps, are presented below. See the headline ''DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION'' in About Data for further information. -- Aluminium foil production--- Fuel oil (kg) 15,2 Gas (kg) 98 Electricity UCTPE* (kWh) 1780 ---Process scrap recycling--- Fuel oil (kg) 0,8 Gas (kg) 69 Electricity UCTPE* (kWh) 156 * UCTPE 94 is an electrical energy model for energy supporting all processes in this system (including transports), except electrolysis and cast house. It is described in BUWAL 250, see litterature references. --- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- RECOMMENDATIONS BY EAA WHEN USING THE DATA The data provided by the EAA members for their own process steps are the most up-to-date average data available for these processes, and it is recommended that they be used for LCA purposes. Older literature data should be disregarded, as it may no longer be representative due to technological improvements, progress in operating performance, changes with regard to raw materials or waste treatment, etc. To complete the product system inventory, data - on the production of consumer products, from semi-fabricated aluminium, - on the performance of consumer products in the use phase, and - on the recovery of scrap prior to remelting at the end of the product's useful life should be acquired. EAA recommend that these data be used in LCA studies in accordance with methodologies within the framework of the international standards in the ISO 14040-series. RELATED DATA SETS IN SPINE DATA FORMAT The data presented in the Environmental Profile Report is reformatted in to the SPINE format and structured according to the SPINE concept in as many separate activities (sub-systems) as possible. The system scope for the study as a whole is primary aluminium production, semi-finished aluminium production, and recycling. The SPINE formatting resulted in 7 activities. These activities are all published in the SPINE@CPM database. The production and recycling step are intended to be used together. For example, to obtain a cradle to gate-system for rolled aluminium sheet, the activity Primary aluminium production should be connected to the activity Production of rolled aluminium sheet. A recycling step (Aluminium recycling by refiners) could also be connected to such a system, depending on the scope. -- List of activities formatted in the SPINE-format, published in SPINE@CPM -- Primary aluminium production 1. Primary aluminium production Semi-finished aluminium product fabrication 2. Production of rolled aluminium sheet 3. Production of extruded aluminium profiles 4. Production of 0,02-0,2 mm single-rolled aluminium foil 5. Production of 0,005-0,02 mm double-rolled aluminium foil Recycling 6. Re-melting of aluminium scrap 7. Aluminium recycling by refiners Please note: The recycling process 6. Re-melting of aluminium scrap is included in the semi-finished aluminium product fabrication, i.e. activities 2-5. When designing a product system with the activities above where recycled aluminium is regarded, the activity Aluminium recycling by refiners should be used. The Re-melting of aluminium activity is only a specification if the user is specifically interested in this process step. RECYCLING RATES FOR ALUMINIUM PRODUCTS AFTER USE After use, aluminium products are a valuable re-usable resource. The European recycling

	rates for end products are currently around 95% for the automotive sector and 85% for the building sector. IMPROVEMENTS IN THE ENVIRONMENTAL PERFORMANCE OF ALUMINIUM PRODUCTS AND PROCESSES OVER THE PAST FEW YEARS Over the past few years EAA has achieved major improvements in the environmental performance of its production processes by means of the following: - improvement on existing technology - development and introduction of new technology and operations - increased recycling of all materials in the production process. Examples of major environmental improvements in aluminium products achieved over the past few years include: - weight reduction by downgauging in the packaging sector - energy savings through weight reduction and subsequent fuel reduction in the transport sector - reduction of maintenance in the building sector The previous Ecological Profile Report from EAA was published in 1996.
About Data	--- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- PRECISION According to EAA, the environmental data figures in the inventory table are usually accurate to a precision of 5%. DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION The electricity supply systems and fuel production and use (transport energy and emission data) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250' and EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems. All emissions connected with total fuel consumption (i.e. production and combustion of oil, gas or coal) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250', table 16.9. Emissions from combustion only, i.e. excluding the contribution of the production of the fuel, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of production and combustion of fuels in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, in view of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors. REVIEW OUTSPOKE Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, April 2000, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. Ian Bousteds' review comments on the Environmental Profile Report for the European Aluminium Industry, April 2000: ''...I have received the detailed calculations on which this present environmental report is based. All of the queries that I raised after working through these reports were answered satisfactory.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Good-quality data were supplied by the EAA member companies, and the number of companies participating provides good coverage of the various processes, meaning that the results can be regarded as representative of the industryas a whole for the production of primary aluminium and subsequent conversion processes.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Because of the very fragmented nature of the recycling industry and wide variations in practices, it is recognised that the data presented for this sector of the industry can only be regarded as indicative. Nevertheless it is helpful to have such information from an authorative source.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000
Notes	REVIEWER Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. See AboutData for review comments.

SPINE LCI dataset: Production of 0,02-0,2 mm single-rolled aluminium foil

Administrative	
Finished	Y
Date Completed	2002-05-07
Copyright	EAA
Availability	Public

Technical System	
Name	Production of 0,02-0,2 mm single-rolled aluminium foil
Functional Unit	1000 kg aluminium foil (0,02-0,2 mm)
Functional Unit Explanation	Aluminium foil with thickness between 0,02 mm and 0,2 mm
Process Type	Gate to gate
Site	Not specified. See Geographical boundaries for further information.
Sector	Materials and components
Owner	Not specified. See Geographical boundaries for further information.
Technical system description	Aluminium foil is used in varying gauges and in a number of alloys for a variety of applications. It is available in thickness from 5 microns to 200 microns (i.e. 0,005 to 0,2 mm) and can be supplied in a range of finishes. This data set represents the describes of aluminium foil in a thickness of 0,02-0,2 mm. The starting material for the production of rolled aluminium foil is aluminium slab (rolling ingot), which is first rolled into foil stock, i.e. the specific input for foil fabrication. In this documentation, the starting material is referred to as ''aluminium ingot'' when is comes from an external primary or secondary aluminium plant. It is also produced by remelting process scrap internally within this system (Ingot remelting and casting) and this input is referred to as ''casting scrap''. The process steps are: - Aluminium foil production 1. Sawing and scalping 2. Preheating 3. Hot rolling 4. Cold rolling foil stock 5. Cold rolling single 6. Final anneal 7. Finishing 8. Packaging - Process scrap recycling 9. Ingot remelting and casting The production of electricity is included in the system. Some further details on the process step Ingot remelting and casting is given below From the process steps 1-4, Sawing and scalping, Preheating, Hot rolling, and Cold rolling foil stock 589 kg scrap is going to the process step Ingot remelting and casting The process steps 5-8 Cold rolling single, Final anneal, Finishing, and Packaging contributes with additional 234 kg scrap. 36 kg scrap is recycled within the process ingot remelting and casting.

System Boundaries	
Nature Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- Cut-off criteria through out this inventory is basically relevance, as checked by the industry expert team monitoring the work and confirmed by reviewer I. Boustead. As a rough guideline ''less than 1% of total mass'' is applied for the inputs, i.e if the input is less than 1% of the total mass, then it is not included in the inventory table. The base for the choices of included inventory parameters is not further described in the EAA report.

Time Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- The data derived from an industry survey from 1998 and includes literature data from reports dated 1998 and 1999.
Geographical Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- It is not always explicit in the report where the different included process steps take place. Data may be acquired from outside of Europe, e.g. regarding ancillary processes. See litterature references (LitteratureRef) next to the flow table (FlowMetaData) for further information about the data sources for each process step.
Other Boundaries	See Nature boundaries for a specification of the cut-off criteria that has been applied.
Allocations	Allocations are not explicitly specified in the Environmental Profile Report 2000.
Systems Expansions	System expansions are not explicitly specified in the Environmental Profile Report 2000.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Not relevant.
Method	PRODUCTION OF SEMI-FINISHED ALUMINIUM The data derive from an industry survey with a coverage ranging from 20% to 70%, depending on the product in question. INGOT REMELTING AND CASTING (RECYCLING OF PROCESS SCRAP) Data were obtained from aluminium-integrated cast house operations, i.e. cast houses associated with semi-finished aluminium production. The 1998 survey on semi-finished aluminium products also encompassed aluminium-integrated cast houses, with 37% coverage for the recycling of process scrap. TRANSPORTS Transport energy and air emission data have been taken from SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 ELECTRICITY For all manufacturing operations, the consumption of fossil fuels and emissions linked to electricity production was calculated according to the UCTPE 94 electrical energy model as described in BUWAL 250. Emissions from combustion only, i.e. without the precombustion contribution, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of precombustion and combustion in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, inview of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors.
Literature Reference	---Aluminium foil production and process scrap recycling Industry survey from 1998 ---Transport energy, electricity, and air emission - SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems.
Notes	Includes electricity produced by nuclear and hydro power (hydro 263 kWh and nuclear 647 kWh). In this inventory profile it is possible to identify which process step (Aluminium foil production, Process scrap recycling) the flow is connected to, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling.	Input	Natural resource	Brown coal	193			kg	Ground	
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling.	Input	Natural resource	Crude oil	58			kg	Ground	
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling.	Input	Natural resource	Hard coal	183			kg	Ground	
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling.	Input	Natural resource	Natural gas	175			kg	Ground	
Notes: This substance is connected to the process scrap recycling. 7,8 kg is alloy additives as master alloys and 8,7 kg in pure form.	Input	Refined resource	Alloying additives	16.5			kg	Technosphere	
Notes: This substance is connected to the aluminium foil production.	Input	Refined resource	Aluminium ingot	1027			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Ar-gas	1.6			kg	Technosphere	

Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Chlorine	0.013			kg	Technosphere	
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling.	Input	Refined resource	Electricity	647			kWh	Technosphere	
Notes: This substance is connected to the process scrap recycling. Fluxing agents = salts.	Input	Refined resource	Fluxing agents	0.66			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Nitrogen	0.69			kg	Technosphere	
Notes: This substance is connected to the aluminium foil production. It is used for packaging.	Input	Refined resource	Paper and cardboard	0.12			kg	Technosphere	
Notes: This substance is connected to the aluminium foil production. It is used for packaging.	Input	Refined resource	Plastics	0.49			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Refractory materials	0.86			kg	Technosphere	
Notes: This substance is connected to the aluminium foil production.	Input	Refined resource	Rolling oil	31			kg	Technosphere	
Notes: This substance is connected to the aluminium foil production. It is used for packaging.	Input	Refined resource	Steel	2.4			kg	Technosphere	
Notes: This substance is connected both to the aluminium foil production and the process scrap recycling. It is used for cooling.	Input	Refined resource	Water	100			m3	Technosphere	
Notes: This substance is connected to the aluminium foil production. It is used for packaging.	Input	Refined resource	Wood	39			kg	Technosphere	
Notes: This substance derives from the process scrap recycling.	Output	By-product	Aluminium skimmings	27.7			kg	Technosphere	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	CH4	2.7			kg	Air	
Notes: This substance derives from the process scrap recycling.	Output	Emission	Chlorides	0.0028			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	Chlorides	3.4			kg	Water	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	CO	0.30			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	CO2	1090			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	COD	0.004			kg	Water	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	Dust	0.85			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling. HC (other than CH4).	Output	Emission	HC	1.0			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	HCl	0.14			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	HF	0.012			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling. NH3 = ammonia.	Output	Emission	NH3	0.0020			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	NOx	1.9			kg	Air	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	Oil/grease	0.085			kg	Water	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	SO2	3.9			kg	Air	

Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Emission	Suspended particles	0.43			kg	Water	
Notes: This substance derives from the foil production.	Output	Emission	VOC	6.4			kg	Air	
	Output	Product	Aluminium foil (0,02-0,2 mm)	1000			kg	Technosphere	
Notes: This substance derives from the foil production.	Output	Residue	Hazardous waste	11			kg	Technosphere	
Notes: This substance derives from the foil production.	Output	Residue	Oil	9.8			kg	Technosphere	
Notes: This substance derives from both the foil production and the process scrap recycling.	Output	Residue	Solid waste unspecified	16			kg	Technosphere	

About Inventory

Publication	Environmental Profile Report for the European Aluminium Industry, European Aluminium Association, April 2000 -- Data documented by: Maria Erixon, IMI, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 8 May 2002 --
Intended User	LCA-practitioners.
General Purpose	The European Aluminium Association (EAA) aims to contribute to further environmental improvements in aluminium products in a life cycle concept.
Detailed Purpose	The purpose with the Environmental Profile Report 2000 is to provide LCA-practitioners with detailed and up-to-date information representing the aluminium industry activities in Europe. The purposes with formatting the Environmental Profile Report 2000 for the European Aluminium Industry to the data documentation format SPINE, according to the data documentation criteria applied at Centre for environmental assessment of Product and Material systems (CPM) are: - CPM and European Aluminium Association (EAA) are anxious to provide life cycle assessment (LCA) practitioners with accurate and up to date environmental data for aluminium production. - EAA is interested in the SPINE formatting procedure and result, as the format is a base for (and therefor somewhat similar to) the new Technical Specification in ISO, ISO 14048, regarding LCA data documentation format. - EAA is interested in the CPM data quality control and documentation criteria.
Commissioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Practitioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Reviewer	Dr. Ian Boustead, - 2 Black Cottages West Grinstead, Horsham GB-West Sussex RH13 7BD
Applicability	--- SPECIFIC INFORMATION FOR THIS DATA SET --- ENERGY USE IN THE DIFFERENT INCLUDED PROCESS STEPS The energy directly consumed by the operations enclosed within the system bounderies, i.e. in the various production steps, are presented below. See the headline ''DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION'' in About Data for further information. Aluminium foil production--- Fuel oil (kg) 5,2 Gas (kg) 75 Electricity UCTPE* (kWh) 1475 ---Process scrap recycling--- Fuel oil (kg) 0,7 Gas (kg) 57 Electricity UCTPE* (kWh) 130 * UCTPE 94 is an electrical energy model for energy supporting all processes in this system (including transports), except electrolysis and cast house. It is described in BUWAL 250, see litterature references. --- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 ---

		RECOMMENDATIONS BY EAA WHEN USING THE DATA The data provided by the EAA members for their own process steps are the most up-to-date average data available for these processes, and it is recommended that they be used for LCA purposes. Older literature data should be disregarded, as it may no longer be representative due to technological improvements, progress in operating performance, changes with regard to raw materials or waste treatment, etc. To complete the product system inventory, data - on the production of consumer products, from semi-fabricated aluminium, - on the performance of consumer products in the use phase, and - on the recovery of scrap prior to remelting at the end of the product's useful life should be acquired. EAA recommend that these data be used in LCA studies in accordance with methodologies within the framework of the international standards in the ISO 14040-series. RELATED DATA SETS IN SPINE DATA FORMAT The data presented in the Environmental Profile Report is reformatted in to the SPINE format and structured according to the SPINE concept in as many separate activities (sub-systems) as possible. The system scope for the study as a whole is primary aluminium production, semi-finished aluminium production, and recycling. The SPINE formatting resulted in 7 activities. These activities are all published in the SPINE@CPM database. The production and recycling step are intended to be used together. For example, to obtain a cradle to gate-system for rolled aluminium sheet, the activity Primary aluminium production should be connected to the activity Production of rolled aluminium sheet. A recycling step (Aluminium recycling by refiners) could also be connected to such a system, depending on the scope. -- List of activities formatted in the SPINE-format, published in SPINE@CPM -- Primary aluminium production 1. Primary aluminium production Semi-finished aluminium product fabrication 2. Production of rolled aluminium sheet 3. Production of extruded aluminium profiles 4. Production of 0,02-0,2 mm single-rolled aluminium foil 5. Production of 0,005-0,02 mm double-rolled aluminium foil Recycling 6. Re-melting of aluminium scrap 7. Aluminium recycling by refiners Please note: The recycling process 6. Re-melting of aluminium scrap is included in the semi-finished aluminium product fabrication, i.e. activities 2-5. When designing a product system with the activities above where recycled aluminium is regarded, the activity Aluminium recycling by refiners should be used. The Re-melting of aluminium activity is only a specification if the user is specifically interested in this process step. RECYCLING RATES FOR ALUMINIUM PRODUCTS AFTER USE After use, aluminium products are a valuable re-usable resource. The European recycling rates for end products are currently around 95% for the automotive sector and 85% for the building sector. IMPROVEMENTS IN THE ENVIRONMENTAL PERFORMANCE OF ALUMINIUM PRODUCTS AND PROCESSES OVER THE PAST FEW YEARS Over the past few years EAA has achieved major improvements in the environmental performance of its production processes by means of the following: - improvement on existing technology - development and introduction of new technology and operations - increased recycling of all materials in the production process. Examples of major environmental improvements in aluminium products achieved over the past few years include: - weight reduction by downgauging in the packaging sector - energy savings through weight reduction and subsequent fuel reduction in the transport sector - reduction of maintenance in the building sector The previous Ecological Profile Report from EAA was published in 1996.
	About Data	--- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- PRECISION According to EAA, the environmental data figures in the inventory table are usually accurate to a precision of 5%. DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION

	The electricity supply systems and fuel production and use (transport energy and emission data) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250' and EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems. All emissions connected with total fuel consumption (i.e. production and combustion of oil, gas or coal) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250', table 16.9. Emissions from combustion only, i.e. excluding the contribution of the production of the fuel, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of production and combustion of fuels in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, in view of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors. REVIEW OUTSPOKE Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, April 2000, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. Ian Bousteds' review comments on the Environmental Profile Report for the European Aluminium Industry, April 2000: ''...I have received the detailed calculations on which this present environmental report is based. All of the queries that I raised after working through these reports were answered satisfactory.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Good-quality data were supplied by the EAA member companies, and the number of companies participating provides good coverage of the various processes, meaning that the results can be regarded as representative of the industryas a whole for the production of primary aluminium and subsequent conversion processes.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Because of the very fragmented nature of the recycling industry and wide variations in practices, it is recognised that the data presented for this sector of the industry can only be regarded as indicative. Nevertheless it is helpful to have such information from an authorative source.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000
Notes	REVIEWER Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. See AboutData for review comments.

SPINE LCI dataset: Production of a Corrugated Board Box (182*62*182)

Administrative	
Finished	Y
Date Completed	2000-01-18
Copyright	FEFCO, Groupement Ondulé, KRAFT Institute
Availability	The database is available from KRAFT Institute without cost.

Technical System	
Name	Production of a Corrugated Board Box (182*62*182)
Functional Unit	One corrugated board box (182*62*182) mm
Functional Unit Explanation	The box is made of two layers of kraftliner and one layer of semichemical fluting.
Process Type	Gate to gate
Site	European average
Sector	Materials and components
Owner	European average

Technical system description	Corrugated board is composed of layers of paper: liner (linerboard) and fluting (corrugating medium) The four major paper grades used for the production of corrugated board boxes are Kraftliner, Testliner, Semichemical Fluting and Wellenstoff. The composition of the corrugated box depends of the function that it has to fulfil. Only the processes within the mill are included. That is, no transports to or from the mill are included. The forestry processes or paperproduction are included. Corrugated board is manufactured on a corrugator which consists of several steps running in line. In the process five steps are distinguished: 1. Shaping of the corrugated medium into continuous rolling waves (the flutes) and gluing the first linerboard facing. 2. Gluing one or more web of single faces and facings forming corrugeted board. 3. Creasing and cutting of the corrugated board web in the machine direction. 4. Cutting of the corrugated board web in the cross-machine direction. 5. Stacking of the corrugated sheets before finishing. The corrugated sheets are die-cut into box blanks i.e. any pre-cut section of corrugated board to be formed into a set-up box or portion of a box. The box itself is then ready for use.

System Boundaries

Nature Boundary	Emissions from fuel combustion outside the mill is not included in the data. Emissions to air from the sites have been reported. Emissions from incineration of rejects with energy recovery at the mill are included. Emissions in the steam of the paper mill are not included. Emissions to air originating from the use of biogas from the mills anaerobic wastewater treatment are included. Water that is taken in has to be treated before it is used in the process, and it is again treated after the process before it is released as effluent to a recipient. The substances in the effluent after wastewater treatment are reported.
Time Boundary	Thsi dataset is based on data from ''European Database for Corrugated Board-Life Cycle Studies'' where the data are from 1996. There will come an update on the database in the year 2000 where the data will be based on 1999.
Geographical Boundary	The data are average, based on 42 production plants, for production in Europe.
Other Boundaries	No transports to or from the mill are included. The forestry processes or the production of kraftliner and semichemical fluting are not included.
Allocations	Allocations have been made according to weight and proportions for the manufacturing of corrugated board boxes.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996-01-01
Data Type	Derived, statistics
Represents	European average
Method	Data are all taken from the Eropean Database for Corrugated Board-Life Cycle Studies
Literature Reference	Eropean Database for Corrugated Board-Life Cycle Studies
Notes	Includes electricity produced by nuclear and hydro power (hydro 263 kWh and nuclear 647 kWh). In this inventory profile it is possible to identify which process step (Aluminium foil production, Process scrap recycling) the flow is connected to, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Diesel	1.927e-3			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Bought electricity, the	Input	Refined resource	Electricity	0.0790			MJ	Technosphere	Europe

electricity produced within the plant.									
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Glue	2.482e-6			g	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Heavy oil	0.0655			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Kraftliner	165.4			g	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Light fuel oil	0.0212			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	LPG	0.01156			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Natural gas	0.189			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Semichemical fluting	Input	Refined resource	Semichemical Fluting	24.8			g	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Starch	5.1066			g	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: BOD 5	Output	Emission	BOD	0.0578			g	Water	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	CO2	17.1503			g	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	COD	0.256			g	Water	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	Dust	3.854e-3			g	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle	Output	Emission	NOx	0.0308			g	Air	Europe

Studies Notes: Counted as NO2.									
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Counted as SO2	Output	Emission	SOx	0.0674			g	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	Susp solids	0.0482			g	Water	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: The main product is a corrugated board box.	Output	Product	Corrugated Board Box	106.7			g	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: The waste goes to waste treatment.	Output	Residue	Board	86			g	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: This waste is unspecified.	Output	Residue	Industrial waste	1.0213			g	Landfill ground	Europe

About Inventory

Publication	The data are calculated from ''Eropean Database for Corrugated Board-Life Cycle Studies'' which is a public report published by FEFCO, Groupement Ondulé and KRAFT Institute. -- Data documented by: Åsa Ekdahl, M Sc. student at the dept. of Environmental Systems Analysis, Chalmers University of Technology and SKF Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	The intended users are LCA-pra
General Purpose	The purpose is to provide the industry and its customers the up-to-date knowledge, based on facts concerning the impact of the industry on the environment. Through this database the industry aims to make a contribution to the increasing need for basic environmental data for LCA studies, available in a transparent way. However, these data have been calculated for a box with the dimensions (182*62*182) mm.
Detailed Purpose	This data set has been documented specially for use in the study: ''LCA on SKF's Spherical Roller Bearing 24024''. The aim of the study is to descibe the environmental properties of the bearing as well as identify the processes contributing most to the environmental impact. It has also been calculated for a box with the dimensions (182*62*182) mm used for the specific bearing.
Commissioner	KRAFT Istitute - Norrtullsgatan 43 S-113 45 Stockholm .
Practitioner	Manufacurers of Corrugated Board in Europe - .
Reviewer	
Applicability	The data are applicable only to this specific box dimensions and composition of materials. Data for the production of Kraftliner and Semichemical fluting from the ''European Database for Corrugated Board-Life Cycle Studies'', that can be used together with this activity, is available in SPINE@CPM. These activites are named: - Production of Kraftliner - Production of Semichemical Fluting

About Data	
Notes	

SPINE LCI dataset: Production of Alkyl Polyglucosides (APG) from coconut oil

Administrative	
Finished	Y
Date Completed	95-01-01
Copyright	Carl Hanser Verlag
Availability	Public

Technical System	
Name	Production of Alkyl Polyglucosides (APG) from coconut oil
Functional Unit	1000 kg
Functional Unit Explanation	All emissions, use of resources and energy consumption is based on 1000 kg of APG.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	BRIEF DESCRIPTION: The following steps are involved in the production of APG: Coconut oil production: Process data for the production of coconut oil relate to the procurement and processing Philippine coconut oils. The country represents a major exporting country for this type of oil. Corn production: The process involves spreading of fertilisers and harvesting. Nitrogen fertiliser production: Nitrogen fertiliser is used for the corn production (cultivation of corn). Nitrogen is applied in the form of ammonia, which is manufactured by steam reforming of natural gas. Phosphorous fertiliser production: Phosphor fertiliser is used for the corn production (cultivation of corn). Phospate is applied as P2O5, which is produced by the action of sulphuric acid on phosphate rock. Potassium fertiliser production: Potassium fertiliser is used for the corn production (cultivation of corn). Potassium is generally applied in the form of KCl. The production process includes sylvite mining and processing, KCl production and potassium fertiliser production. Lime/lime stone production: Limestone is used for the corn production and is quarried from open pits. The process involved blasting, crushing screening and finally calcination of the limestone into lime. Sulphur production: No details were given om sulphur production. Glucose monohydrate production: Glucose monohydrate is produced from corn and sulphur. The process involves cleaning, wet milling, light milling, thourough milling, enzyme/enzyme hydrolysis and crystallisation. Salt production: Salt is used in the APG production process. No details were given on salt production. Caustic soda production: Caustic soda is used in the APG production process. No details were given on caustic soda production.

	APG production: APG is derived from fatty alcohols and glucose monohydrate by the Fischer Synthesis. Salt and caustic soda is also used in the process. Information concerning all the subsystems described above: Transports are included in the system. The fuels for the transports and the fuels for the processes are traced back to the extraction of petrochemical raw materials and/or extraction of bio fuels. The electricity data are based on the electricity profile for each country and the petrochemical and biomass raw materials for electricity production are traced back to the extraction process (same process as for fuel raw materials).

System Boundaries

Nature Boundary	All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The process data used pertain mainly to 1992, being yearly averages where possible. It is recognised that operating processes and conditions are constantly evolving.
Geographical Boundary	This study examined the surfactant production in Europe, notably manufacturing processes conducted in Belgium, France, Germany, Italy, the Netherlands, Spain and the United Kingdom. Raw materials may be produced outside of Europe. Therefore, relevant input data from Malaysia, the Philippines and the United States of America have also been incorporated.
Other Boundaries	The detergent formulation, use and final disposal of the surfactants were not covered. The environmental effects associated with the manufacture of capital equipment and with energy and fuel requirements for plant and building conditioning (heat, air etc.) were not included, neither were those associated with personnel requirements. For electricity based on nuclear power and wind power, no emissions and resource exploits have been accounted for.
Allocations	Raw materials, energy and environmental emissions are allocated among co-products on an output weight basis, i.e. on the basis of mass. Co-products in this LCI include those materials that are currently recycled, reused or marketed in some beneficial way.
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study).

Flow Data

General Activity QMetaData

Date Conceived	1992
Data Type	Derived, unspecified
Represents	European average
Method	LC-inventory data from tables 1 and 3-5, pages 196-197 in lit.ref.
Literature Reference	Tenside Surfactants Detergents; 32. Jahrgang 2/1995; Carl Hanser Verlag; Munchen
Notes	The raw material data are given in ''kg'' and the energy data are given in ''MJ''. However, it is important to remember that the raw materials themselves have an energy content.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Raw material.	Input	Natural resource	Coal	1			kg	Ground	
Notes: Energy resource. The thermal value of coal is 27 MJ/kg.	Input	Natural resource	Coal	6669			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Coconuts	1319			kg	Ground	
Notes: Energy resource. the thermal value of coconuts is 27 MJ/kg.	Input	Natural resource	Coconuts	1755			MJ	Ground	
Notes: Energy resource. The thermal value of crude oil is 42 MJ/kg.	Input	Natural resource	Crude oil	6426			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Limestone	77			kg	Ground	
Notes: Raw material.	Input	Natural resource	NaCl	4			kg	Ground	

Notes: Raw material.	Input	Natural resource	Natural gas	18.2			kg	Ground	
Notes: Energy resource.	Input	Natural resource	Natural gas	9900			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Sulphur	1			kg	Ground	
Represents: Electricity produced by hydro power.	Input	Refined resource	Hydro power	300			MJ	Technosphere	
Notes: Raw material.	Input	Refined resource	Nitrogen fertiliser	12.7			kg	Technosphere	
Represents: Electricity produced by nuclear power.	Input	Refined resource	Nuclear	1690			MJ	Technosphere	
Notes: Raw material.	Input	Refined resource	Phosphorous fertiliser	6.8			kg	Technosphere	
Notes: Raw material.	Input	Refined resource	Potassium fertiliser	9.6			kg	Technosphere	
	Output	Emission	Acid	2.26			kg	Water	
	Output	Emission	Aldehydes	24			g	Air	
	Output	Emission	BOD	6.35			kg	Water	
	Output	Emission	CH4	5.6			g	Air	
	Output	Emission	Chlorine	10			g	Air	
	Output	Emission	CO	2.87			kg	Air	
Notes: Non-fossil emissions of CO2.	Output	Emission	CO2	150			kg	Air	
Notes: Fossil emissions of CO2.	Output	Emission	CO2	1623			kg	Air	
	Output	Emission	COD	7			kg	Water	
	Output	Emission	Cr	5.84			mg	Water	
	Output	Emission	Dissolved solids	21.2			kg	Water	
	Output	Emission	Fe	1.96			kg	Water	
	Output	Emission	Fluorides	0.01			kg	Water	
	Output	Emission	Fluorine	0.01			kg	Air	
	Output	Emission	HC	0.11			kg	Water	
	Output	Emission	HC	15.7			kg	Air	
	Output	Emission	HCl	0.14			kg	Air	
	Output	Emission	HF	1.2			g	Air	
	Output	Emission	Hg	1.12			mg	Water	
	Output	Emission	Hg	12.5			mg	Air	
	Output	Emission	Kerosene	0.11			mg	Air	
	Output	Emission	Metal ion	0.013			kg	Water	
	Output	Emission	Metals	0.01			kg	Air	
	Output	Emission	NH3	18			g	Air	
	Output	Emission	Ni	1.03			mg	Water	
	Output	Emission	NOx	13.1			kg	Air	
	Output	Emission	N-tot	1.96			kg	Water	
	Output	Emission	Odorous sulphurs/thiols	1.2			g	Air	
	Output	Emission	Oil	0.0071			kg	Water	
	Output	Emission	Other chemicals	1.42			mg	Water	
	Output	Emission	Other organics	0.46			kg	Air	
	Output	Emission	Particles	11.7			kg	Air	
	Output	Emission	Pb	0.467			mg	Water	
	Output	Emission	Pb	22.9			mg	Air	
	Output	Emission	Phenol	0.011			kg	Water	
	Output	Emission	SOx	14			kg	Air	
	Output	Emission	Sulphides	0.776			g	Water	
	Output	Emission	Susp solids	12.2			kg	Water	
	Output	Emission	Zn	5.13			mg	Water	
	Output	Product	Alcyl Polyglucosides	1000			kg	Technosphere	
	Output	Residue	Solid waste	135			kg	Ground	

About Inventory

Publication	Tenside Surfactants Detergents; 32. Jahrgang 2/1995; Carl Hanser Verlag; Munchen --- Data documented by: Malin Ericson, Akzo Nobel Surface Chemistry Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of

	Technology --
Intended User	Manufacturers and users of sur
General Purpose	-To produce an authoritative and comprehensive Life Cycle Inventory for major surfactant production in Europe through a common approach in order to facilitate objectivity in surfactant assessments on environmental grounds. -To secure the best possible validation of data and broad acceptance of the methodology and conclusions by industry, regulatory authorities, and academia, through assessment of the study by an appropriate expert review panel.
Detailed Purpose	-To establish an industry-wide inventory of the energy and emissions associated with the production of major surfactants in Western Europe under the conditions prevailing in 1992. -To bring together environmental data on the use of the main raw material sources - crude oil, natural gas, mineral, oleochemical, agricultural feedstock - for the processing pathways to the derived major surfactants. -To provide benchmarks for the processing steps of surfactant production against which individual producers can assess their own processes and identify opportunities for improvement. -To publish the results of the study and its conclusions in the open literature for access and reference by interested bodies.
Commissioner	- European LCI Surfactant Study Group (CEFIC/ECOSOL).
Practitioner	- Franklin Associates, Ltd. 4121 W. 83rd St., Suite 108 Prairie Village, KS 66208, USA.
Reviewer	Klöppfer, Prof. Dr. W. - C.A.U. Consultants Frankfurt, Germany
Applicability	It is generally not possible to replace one surfactant type by another without changing other components of a preparation, or altering performance characteristics. Therefore, it is not in general meaningful to compare surfactants on a weight basis. APGs comprise a comparatively new class of commercial surfactants. APGs show interesting synergy with other surfactants, which can enable the reduction of acrive ingredients at the same perfromance level. Besides their application in detergents they are well-suited to several cosmetic formulations and other surfactant applications, where special foaming abilities are required.
About Data	13 industrial companies participated in the project, including major surfactant manufacturers, raw material and intermediate suppliers, as well as surfactant users in Europe, some of whom are both manufacturers and users. Participating companies are BASF, Colgate-Palmolive, Condea, Enichem Augusta, Henkel, Hoechst, Hüls, ICI, Petresa, Procter & Gamble, Shell, Unilever and Wibarco. Process data were obtained directly from each company performing the process. These data were often proprietary. Therefore, technical process data from private corporations were collected from a minimum of three producers for each intermediate and surfactant type. The information is presented in the form of industry averages in order to preserve confidentiality. Fuel-related data for European countries were based on various governmental statistics and industry contacts (aggregated and provided by Dr. I. Bousted, The Open University, U.K.).
Notes	Data for other surfactants such as Alcohol sulphates (AS), Alcohol ethoxy sulphates (AES), soap, Secondary alkane sulphonates (SAS), Alcohol ethoxylates (AE) and Linear alkylbenzene sulphonates (LAS) were given in the same study.

SPINE LCI dataset: Production of ammonia

Administrative	
Finished	Y
Date Completed	99-01-25
Copyright	
Availability	Public (confidential parameter in flow data is not included)

Technical System	
Name	Production of ammonia
Functional Unit	1 kg of ammonia (100 %)

Functional Unit Explanation	
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Exactly what techniques the data represent in this dataset is uncertain as the data are average data from literature. No specific production site has been studied. The text below only gives generic information about production of ammonia. Further information on interpretations of what the data represent is given under ''method'' in the flow data window. In theory, the synthesis of ammonia based on a methane feedstock, is (BAT N° 1, 1995): 1) 0.88 CH_4 + 1.24 H_2O ® 0.88 CO_2 +3 H_2 2) 3 H_2 + N_2 (from air) ® 2 NH_3 In industrial ammonia production the process may be subdivided into the following sections: a) Synthesis gas preparation 1) Gas production 2) Carbon monoxide conversion 3) Gas purification b) Compression c) Synthesis of ammonia The goal of synthesis gas preparation is to produce a gas mixture of nitrogen and hydrogen as pure as possible in the stoichiometric ratio of 1:3 (Ullman, vol. A 2, 1985). This can be done with different techniques. Currently in operation in Europe, the main types of production process for synthesis gas preparation are: a) Steam reforming of natural gas or other light hydrocarbons (liquidified natural gas, liquidified petroleum gas, naphtha) b) Partial oxidation of heavy fuel oil or vacuum residue Overall, gasification of hydrocarbons or coal can be seen as a partial oxidation at elevated temperatures. The main products are hydrogen and carbon monoxide. The necessary oxygen can be supplied either as steam, as oxygen or as air. If a catalyst is used and steam is the primary gasification medium, then the process is called steam reforming. If the reactant is oxygen or air and no catalysts are used, the process is called partial oxidation (Ullman, vol. A 2, 1985). About 85 % of world ammonia production is based on steam reforming concepts. Comparing natural gas reforming, heavy oil and coal gasification gives the approximate relative energy consumption figures of 1:1,3:1,7. Based on the known resources of fossil fuel, it is likely that natural gas will predominate as feedstock for the production of ammonia for the next 50 years at least. Today, about 77 % of world ammonia production is based on natural gas. In a long-term perspective, 50 to 100 years from now, coal may take over as feedstock, based on world reserves and consumption rate. Heavy oil may be attractive under special economical concerns, when natural gas is no longer available and the partial oxidation process could solve a waste problem (e.g. heavy residues and recycled plastics) (BAT N° 1, 1995) Three reforming techniques and one partial oxidation technique (of heavy residues) will be described briefly. Conventional steam reforming will be described more in detail and only deviations and additions will be stated for the other processes. Conventional Steam Reforming Desulphurization Most of the catalysts involved in the ammonia production process are sensitive to sulphur and sulphur compounds. The first step is therefore to desulphurize the feedstock. The feed gas is preheated to 350-400°C and is then treated in a desulphurization vessel. The sulphur that is not already in the form of hydrogen sulphide (H_2S) is hydrogenated to hydrogen sulphide, typically using a cobalt molybdenum catalyst. The hydrogen sulphide is then adsorbed on pelleted zinc oxide: 1) R-SH + H_2 ® H_2S + RH 2) H_2S + ZnO ® ZnS + H_2O By this reaction, the sulphur is removed to less than 0.1 ppm S in the gas feed. The hydrogen consumed in the reaction is usually recycled from the ammonia synthesis section. Primary Reformer The gas from the desulphurizer is preheated with steam to 500-600°C before entering the primary reformer. The process steam comes from an extraction turbine. In some plants a prereformer is used, in that case the gas steam mixture is reheated again in the section between the prereformer and primary reformer.

The primary reformer consists of a large number of high-nickel chromium alloy tubes filled with nickel-containing reforming catalysts. The reaction taking place is as follows:

a) $CH_4 + H_2O$ ® $CO + 3 H_2$
b) $CO + H_2O$ ® $CO_2 + H_2$

The first reaction is highly endothermic and additional heat is required to raise the temperature at the reformer outlet. The heat is supplied from burning of natural gas or other gaseous fuel, in the burners of a radiant box containing the tubes where the reactions take place. The flue-gas from the combustion of this fuel is the main source of emissions from the plant, consisting of carbon dioxide (CO_2), nitrogen oxides (NO_X) and small amounts of sulphur dioxide (SO_2) and carbon monoxide (CO) (BAT N° 1, 1995). Large amounts of carbon dioxide can also be released at the carbon dioxide removal stage if it is not used as feedstock in the production of urea.

Secondary Reformer
In the secondary reformer the remains of hydrocarbon are converted. To do this the temperature must be raised to increase the conversion. This is done by combustion of part of the gas with air. The air not only provides oxygen for the combustion but also nitrogen for the final synthesis of ammonia that takes place further on in the process chain. The process gas is mixed with air in a burner and then passed on over a second nickel-containing reformer catalyst.

Conversion of Carbon Monoxide
After the secondary reformer up to 99 % of the hydrocarbon feed is converted but there is still a 12-15 % content of carbon monoxide left. After cooling the carbon monoxide is therefore converted into carbon dioxide by using iron oxide/chromium oxide catalysts at high temperature and then copper oxide/zinc oxide-based catalysts at low temperature. This carbon monoxide conversion reduces the carbon monoxide content to about 0.2-0.4 %. A low residual carbon monoxide content is important for the efficiency of the process (BAT N° 1, 1995).

Carbon Dioxide Removal
The process gas now contains mainly hydrogen (H_2), nitrogen (N_2), carbon dioxide (CO_2) and excess process steam. Before ammonia can be synthesised carbon dioxide has to be removed. This is done in a chemical or a physical absorption process. The typical range of heat consumption in the modern chemical absorption process is 30-60 MJ/kmol CO_2. The physical absorption process may be designed for zero heat consumption but the mechanical requirements also have to be considered. Before entering the carbon dioxide removal system the process gas is cooled and the heat released during cooling is in many cases used for other heat demanding processes (BAT N° 1, 1995).

Methanation
As the ammonia synthesis catalysts are sensitive to carbon monoxide and carbon dioxide, these have to be removed completely by conversion to methane. With a nickel containing catalysts the following reactions take place at around 300°C:

$CO + 3 H_2$ ® $CH_4 + H_2O$
$CO_2 + 4 H_2$ ® $CH_4 + 2H_2O$

Methane will not react in the synthesis of ammonia, but water must be removed before entering the reaction chamber. Also, the synthesis gas is compressed before the final process stage (BAT N° 1, 1995).

Synthesis of Ammonia
The synthesis of ammonia takes place on an iron catalyst at around 100-250bar and 350-550°C:

$N_2 + 3H_2$ « $2 NH_3$

The reaction is exothermic and produced ammonia is separated by cooling. The equilibrium conditions of the reaction are quite unfavourable resulting in a poor conversion factor of only 20-30 % per pass. Loop pressure is maintained by substituting the ammonia that has been lead off with fresh synthesis gas.

The produced ammonia contains inerts (methane and argon). The level of inerts is kept low by taking out a purge stream from the loop. The purge stream is scrubbed with water to remove ammonia and is then used as fuel or sent to the desulphurization section where hydrogen is recovered.

Steam Reforming with Excess Air Secondary Reforming
The main difference from conventional steam reforming, is that in steam reforming with excess air in the secondary reformer the process is designed for reduced primary reforming by moving some of the duty to the secondary reformer. This is due to the low efficiency of the primary reformer. Reducing the primary reforming is done by decreasing the heat supply and thus the extent of reforming is reduced according to lower heat supply and lower temperature.

By increasing the internal firing by supplying more process air in the secondary reformer the same degree of total reforming as in conventional reforming is achieved. The process air requirement is about 50 % higher than in conventional reforming, this means increased compression capacity and energy demand. Usually, the process air compressor is driven by a gas turbine with the exhaust gas from the turbine being used as combustion air in the primary reformer (BAT N° 1, 1995).

	Before the synthesis gas enters the final stage of ammonia synthesis it passes a cryogenic purifier where all methane and excess nitrogen are removed. The cooling is produced by depressurisation and therefore no external cooling device is needed. By removal of essentially all impurities from the synthesis gas, a higher conversion per pass and a lower purge flow can be achieved in the ammonia synthesis. Heat Exchange Autothermal Reforming In this process the high-level heat from the secondary reformer outlet and the flue-gas from the primary reformer are recycled to the process itself. This is from a thermodynamic point of view better than to use the heat to raise steam as is done in conventional reforming. By using the heat in the gas from the secondary reformer in a newly developed primary reformer (heat exchange reformer), the fired furnace for heating of the primary reformer is eliminated. This reduces the emissions from the plant significantly as the flue-gas from the primary reformer is eliminated. Extra air or oxygen-enriched air is required in the secondary reformer for this autothermal process. Only two processes of this kind are presently in operation in Europe (BAT N° 1, 1995). Partial Oxidation of Heavy Oil The partial oxidation process is non-catalytic and takes place at high pressure (>50 bar) and high temperature (around 1400°C). Besides hydrogen, the formed gas also contains carbon dioxide, carbon monoxide, methane and some soot. The sulphur compounds in the feed are converted to hydrogen sulphide and then separated in a selective absorption step and reprocessed to elemental sulphur in a Claus unit (BAT N° 1, 1995). After conversion of carbon monoxide into carbon dioxide, the carbon dioxide is removed by using an absorption agent. The synthesis gas is then purified in a liquid nitrogen wash. In this unit practically all impurities are removed and nitrogen is added to give the stoichiometric ratio of hydrogen and nitrogen. The ammonia synthesis is quite similar to the one in conventional steam reforming, but simpler and more efficient. This is due to the high purity of the synthesis gas, therefore there is no need to take out a purge flow (BAT N° 1, 1995). Environmental Aspects The most important environmental impact owing to ammonia production is a large consumption of fossil fuel and emissions of fossil carbon dioxide (CO_2) as a consequence. There are also emissions of nitrogen oxides (NO_x), carbon monoxide (CO) and sulphur dioxide (SO_2). The latter is highly dependent on the type of fuel that has been used (BAT N° 1, 1995). In addition, there may be considerable leakage of natural gas (consisting mainly of methane, CH_4) due to the transport of natural gas in pipelines (Karlsson M pers. comm., 1998). References: BAT N° 1 (1995). Production of Ammonia, Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry. EFMA - European Fertilizer Manufacturers' Association, Ave. E van Nieuwenhuyse 4, B-1160 Brussels, Belgium. Karlsson M (1998). Personal communication. Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Ullmann's Encyclopedia of Industrial Chemistry (1985). Volume A 2. p. 175-179

System Boundaries	
Nature Boundary	The system starts with input of electricity, natural gas, crude oil and coal and ends with ammonia leaving the factory gate. Emissions and use of resources for production of electricity and emissions from extraction and combustion of energy resources are not included in this datset.
Time Boundary	The literature from which data are taken from are published in 1996 and 1998.
Geographical Boundary	Central and Eastern Europe.
Other Boundaries	
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	Derived, unspecified
Represents	European average
Method	According to Kongshaug (1998) 32.1 GJ/t NH_3 is the assumed average energy consumption for production of ammonia in Western Europe using the steam reforming process. About 41.2 GJ/t NH_3 is the assumed energy consumption for the most efficient plant 30 years ago and this gives a good indication of the energy consumption in a 30-year-old plant which has

	not been upgraded. The energy consumption for ammonia production using partial oxidation is 41-49 GJ/t NH3 (Kongshaug, 1998). The ammonia used in fertiliser production in Sweden is imported from Russia and Poland and it has been assumed that production techniques in these countries are comparable to the most efficient plants in Europe 30 years ago. This results in an energy consumption of 41.2 GJ/t NH3. When it comes to partitioning the energy consumption between the different energy sources natural gas, oil, coal and electricity, figures from Kongshaug (1998) and Patyk (1996), information on Hydro Agri's ammonia production in Europe and facts from EFMA have been taken into account. According to EFMA (Balken pers. comm., 1998) 0.20-0.29 GJ electricity/t NH3 is consumed when using the steam reforming process and 0.3 GJ/t NH 3 has therefore been chosen as representative for production in Central and Eastern Europe. According to Patyk (1996) there is a partition between the different energy sources natural gas, heavy oil and coal for production of ammonia used in Germany. This partition has been assessed to be representative for the rest of Western Europe when taking the other sources into account. This leads to the division of the energy consumption as follows: 31.6 GJ natural gas /t NH3, 5.33 GJ heavy oil/t NH3 and 3.94 GJ coal/t NH3.
Literature Reference	Balken H van (1998). Personal communication. Issue Manager, Technology, Environment and Safety, EFMA (European Fertilizer Manufacturers' Association), Belgium. Tel. +32 2 663 31 48. Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. Patyk A (1996). International Conference on Application of Life Cycle Assessment in Agriculture, Food and Non-Food Agro Industry and Forestry: Achievements and Prospects. IFEU-Institut für Energie- und Umweltforschung Heidelberg; Wilkensstrasse 3, D-69120 Heidelberg, Germany.
Notes	Emission of N-tot to water is confidential.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Coal	3.94			MJ	Technosphere	Undefined
	Input	Refined resource	Crude oil	5.33			MJ	Technosphere	Undefined
	Input	Refined resource	Electricity	0.3			MJ	Technosphere	Undefined
	Input	Refined resource	Natural gas	31.6			MJ	Technosphere	Undefined
Notes: Confidential.	Output	Emission	N-tot				g	Water	Undefined
	Output	Product	Ammonia	1			kg	Technosphere	Undefined

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources due to the production of fertilisers produced and used in Sweden.
Detailed Purpose	The purpose was not to compare the production of different fertilisers but to generate a thorough inventory of emissions and use of resources due to the production of different fertilisers used in Sweden. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems. The production of ammonia is one step in the line of production of fertilisers containg nitrogen.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The dataset is applicable for production of ammonia in Central and Eastern Europe. It is included in the aggregated datasets for fertiliser production in Sweden (cradle to gate).
About Data	The data are gathered from reports and literature, i.e. information has not been taken from a specific site. The dataset is intended to be reresentative for production of ammonia that is used in fertiliser production in Sweden.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of ammonium nitrate

Administrative	
Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public (confidential energy flow data are not included).

Technical System	
Name	Production of ammonium nitrate
Functional Unit	1 kg of ammonium nitrate (100 % ammonium nitrate)
Functional Unit Explanation	
Process Type	Gate to gate
Site	Hydro Agri AB Box 908 SE-731 29 Köping Sweden
Sector	Materials and components
Owner	Hydro Agri AB Box 908 SE-731 29 Köping Sweden
Technical system description	At the plant operated by Hydro Agri AB in Köping, ammonia and nitric acid are mixed in a reactor. The ammonium nitrate solution is then evaporated in three evaporators using the heat generated in the neutralisation of ammonia and nitric acid. The condensate from the first evaporator is partly recycled to the reactor. The pressure in the second and third evaporator is lower than in the first. The ammonium nitrate solution leaving the last evaporator has a concentration of 95 % ammonium nitrate. The steam from the evaporators is cleaned in a scrubber and further on used for district heating and heating of process water. References: Miljörapport Hydro Agri AB Köping (1998). Official environmental report. Hydro Agri AB, Box 908, 731 29 Köping. Personal communication: Karlsson L-H (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27800

System Boundaries	
Nature Boundary	The system starts at the incoming factory gate and ends at the outgoing factory gate, i.e emissions and use of resources due to the production of input materials and energy are not included in this dataset.
Time Boundary	The data are taken from production in 1997.
Geographical Boundary	The plant is situated in Köping, Sweden.
Other Boundaries	
Allocations	Energy consumption/production from the preceeding nitric acid production step is included in the energy figures. Emissions of nitrogen to water also include contribution from production of nitric acid.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	European average
Method	Amounts of ammonia and nitric acid consumed in the production of ammonium nitrate were calculated by using the molecular mass of nitric acid and ammonia respectively. A large fraction (97 %) of the nitric acid produced at the site is used for production of ammonium nitrate, which was calculated by subtracting the total amount of nitric acid consumed in the production of ammonium nitrate from the total amount of nitric acid produced at the site in 1997. Total amounts of emissions of nitrogen to water and consumption/production of energy due to the production of nitric acid and ammonium nitrate were divided by total amount of ammonium nitrate produced in 1997.
Literature Reference	Miljörapport Hydro Agri AB Köping, (1998). Official environmental report. Hydro Agri AB, Box 908, 731 29 Köping. Personal communication: Andersson B (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27834. Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Karlsson L-H (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27800
Notes	Energy flow data are confidential. Energy consumption/production from the preceeding nitric acid production step is included in these energy figures. Emissions of nitrogen to water also include contribution from production of nitric acid.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Bought from spot market in the Baltic sea, origin is Poland or Russia.	Input	Refined resource	Ammonia	0.213			kg	Technosphere	Sweden
Notes: Confidential. Consumption/production of energy due to the nitric acid production are included in this energy figure.	Input	Refined resource	District heat				MJ	Technosphere	Sweden
Notes: Confidential. Consumption/production of energy due to the nitric acid production are included in this energy figure.	Input	Refined resource	Electricity				MJ	Technosphere	Sweden
Notes: Nitric acid (100 % HNO3).	Input	Refined resource	Nitric acid	0.788			kg	Technosphere	Sweden
Notes: Confidential. Consumption/production of energy due to the nitric acid production are included in this energy figure.	Input	Refined resource	Steam				MJ	Technosphere	Sweden
Notes: Emissions of nitrogen to water due to the nitric acid production are included in this figure.	Output	Emission	N-tot	0.0235			g	Water	Sweden
	Output	Product	Ammonium nitrate	1			kg	Technosphere	Sweden

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. --- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources due to the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other, but to generate a thorough inventory of emissions and use of resources due to the production of different mineral fertilisers. Production of ammonium nitrate is one process step in the production of fertilisers containing nitrogen. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The dataset is applicable for production of ammonium nitrate produced at Hydro Agri AB in Köping, Sweden. The ammonum nitrate is mixed with other components forming calcium ammonium nitrate (CAN) or NPK fertilisers.The dataset is included in aggregated datasets for fertiliser production at Hydro Agri AB in Köping (cradle to gate).

	Note that energy consumption/production in to the preceeding step of nitric acid production is included in this dataset.
About Data	Data are collected from the official environmental report distributed by Hydro Agri AB in Köping and also by contact with Lars-Håkan Karlsson and Bo Andersson, Hydro Agri AB in Köping. Energy flow data are confidential and are not included in this dataset.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of bearing rings

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Production of bearing rings
Functional Unit	One inner ring 232/530 IR and one outer ring 232/530 OR
Functional Unit Explanation	One spherical roller bearing 232/530 consists of following components: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 rollers (coated or non-coated) The functional unit for this process is one inner ring 232/530 IR (356 kg) and one outer ring 232/530 OR (387 kg). The data can be used (together with data for the other ingoing components) to calculate environmental impact for a complete spherical roller bearing 232/530. Dimensions of the bearing 232/530: di= 530 mm dy= 980 mm breadth= 355 mm The activities for the production of the other ingoing components are also available at SPINE@CPM: * Production of bearing rollers (á 9.2 kg) * Production of brass cages used for spherical roller bearings * Production of guide rings used for spherical roller bearings and the activity for the production of a complete SRB 232/530 can be found as: * Production of SKF Spherical Roller Bearing 232/530
Process Type	Cradle to gate
Site	SKF Sverige AB415 50 GÖTEBORG
Sector	Materials and components
Owner	SKF Sverige AB415 50 GÖTEBORG
Technical system description	The SKF spherical roller bearing 232/530 contains of an inner and an outer ring, 36 rollers, a guide ring and one brass cage. This data set describes the Production of bearing rings for the SKF spherical roller bearing 232/530. The following process steps are included in this dataset: 1. Production of clean bearing steel 2. Heating of ingot at the rolling mill 3. Forging of ingot into steel bars, 350 mm

4. Production of steel rings
5. Turning of steel rings at SKFs site in Göteborg
6. Heat treatment of bearing rings
7. Ring processes at SKFs site in Göteborg

1, 2, 3, 5 and 7 is documented and available in the SPINE@CPM database.

The mineral oil in the cutting fluid used at SKFs site in Göteborg is followed from the cradle with the activities:
8. Extraction of crude oil
9. Refining of crude oil
And to the grave with the activity:
10. Combustion of waste oil

The steel scrap from the ringprocesses at SKFs site in Göteborg is sent to Ovako Steel AB in Hofors for recycling.

All transports between the different sites are included and also the production of diesel, electricity, light fuel oil, LPG and heavy fuel oil.
The transports are:
A. Transport with truck from Hofors - Söderfors (ingot)
B. Transport with truck from Söderfors - Hofors (steel bars)
C. Train transport Hofors - Sävenäs (steel rings)
D. Train transport Sävenäs - Hofors (steel scrap for recycling)
E. Transport with truck Göteborg - Halmstad (cutting fluid)

1. Production of clean bearing steel:
Roller bearings must be produced from extremely clean steel that possesses maximum fatigue strength. SKF had realized this already by 1916 when they bought the Hofors Steel Mill, followed by the Hällefors Steel Mill in 1957. This cooperation with SKF has made the company now called Ovako Steel AB the world`s leading producer of bearing steel.
The steel produced at Ovako Steel AB in Hofors, Sweden, the raw material for the outer and inner rings, is completely produced from scrap. New data has been obtained for all process steps.

When the scrap arrives at Ovako Steel AB in Hofors it is sorted according to quality and alloy elements. The scrap is melted in an electric arc furnace where oxygen and carbon is added. The addition of oxygen and carbon makes the slag porous and in turn makes the process more effective. When the scrap is completely melted the slag is removed and the melt is poured into a ladle furnace where the steel is degassed and final adjustments of the alloys are made. The steel is then teemed uphill into ingot moulds. The moulds are finally removed.

2. Heating of ingot at the rolling mill:
At the rolling mill at Ovako Steel in Hofors the ingots are rolled into billets.
The ingots are first heated in a soaking pit to the proper rolling temperature. When the ingot has been rolled in the first stand of rolls it is transported to the oxygen-scarfing machine where surface defects are removed from the billet. The billet rolling is then continued in rolling stand 2 and 3. Depending on what will become of the ingot it is rolled to round or square billets. Finally the billets are inspected and surface defects, if any, are removed by grinding.

IN THIS SPECIFIC CASE THE INGOT IS ONLY HEATED IN THE SOAKING PIT AT THE ROLLING MILL. Instead of rolling in the rolling stands the ingot is transported to Scana Steel AB in Söderfors for forging into bars.

3. Forging of ingot into steel bars, 350 mm:
The ingot is after the rolling mill transported to Scana Steel AB in Söderfors for forging into bars, 350 mm, and then back to Ovako Steel AB in Hofors to the final treatment at the ring mill.
The ingot is cold when the process starts at the forge at Scana Steel AB in Söderfors. As a first step the ingot is heated in an oven. The first part of the oven heats the ingot from room temperature to 180°C immediately. The ingot is then transported through different temperature areas and is slowly heated until it reaches 1150°C. This heating process takes approximately 1-2 days.
The next process step is pressing in the forging press. The heated ingot is put in the press and edged into round shape. Finally the now nearly round bars are pressed complete round while rotating against a round swage in form of two half circles. The forging is completed and the forged bars are inspected and cooled in room temperature for approximately one day.
The forged bars are transported back to Ovako Steel AB in Hofors by truck.

4. Production of steel rings:
The production of the rings takes place at the ring mill (ring mill number 9) at Ovako Steel AB in Hofors, Sweden. The process steps for the inner and outer ring are completely the same, and therefore the process will be described only once.
The forged bars (blanks) from Scana Steel AB in Söderfors are cut cold in a Wagner sawing machine and heated in rotating hearth furnaces. The blanks are then upset and pierced in a press. The pierced blanks are subject to intermediate heating in a batch furnace before finish rolling in an axial/radial rolling mill. The rings are rolled to a certain profile specific to the demands of SKF.
After forging and rolling the rings have their final dimensions. The rings are heat treated to obtain the required material properties and the oxide scale formed during the treatment is then blasted off. The rings are packed and transported by train to SKF in Göteborg,

	Sweden. 5. Turning of steel rings at SKFs site in Göteborg: The rings from Ovako Steel AB are treated further at the SKF production plant in Göteborg. The ring processes at SKF can be divided into three main steps: 1. Soft treatment 2. Hardening 3. Hard treatment For large sized bearings more work is done by hand and a smaller quantity is produced. The soft treatment starts with turning for both rings. The rings are turned into their final shape. For the outer ring this also means that a channel with holes for lubrication is made. For the SRB 232/530 the turning process takes place at the C-factory in production channel 23 for both rings. After the turning both the rings are inspected by ultra sound. This is done for 100% of the rings of this dimension. The reason is to make sure that the material is solid and homogenous through the whole ring. If a crack would be discovered the whole ring will be scrapped. 6. Heat treatment of bearing rings After the ultra sound inspection the rings are hardened. The data set for the heat treatment of bearing rings is obtained from an earlier LCA study of medium-sized bearings by Åsa Ekdahl and can be found in SPINE@CPM database. In the hardening process the rings are heat treated to make the metal harder and tougher. The heat treatment proceeds through an oven with 9 different positions. The outer and inner rings are treated differently since the thickness of the rings differs. The processes as such are similar and the final material is for both rings bainite, but the temperatures and holding times to obtain the structure are different. First the rings are heated in the first part of the oven. The inner ring is heated to 885°C and the outer ring to 870°C. The function of the last part of the oven is to hold the temperature, during the specific time it takes for the material to get the right properties. The rings are then quenched in a salt bath to 210°C. The rings are kept in the salt bath for the time needed for the material to change. The temperature kept in the last salt bath is 235°C for both rings, but the holding time is longer for the inner ring. The salt bath is half sodium nitrite and half potassium nitrate kept in solution. The salt bath also gives the rings a protective layer of salt. 7. Ringprocesses at SKFs site in Göteborg The hard treatment begins with grinding. Both sides on both rings are ground because of the need of reference surfaces when inspected with ultra sound. Additional material is turned off and the scrap is sent back to Ovako Steel AB for recycling. After the turning the inner ring is polished and the outer ring is ground once again. This is the only difference between the two rings in the process at SKF. The jacket surface of the outer ring is spherically ground to be able to hold the rollers in place. In this step the outer ring also obtains its checked pattern on the inside, so that the lubricant can spread easily on the steel surface. The rings are now ready for assembling.

System Boundaries

Nature Boundary	For the process steps 1-4 both emissions to air and water are included. For the processes at SKFs site in Göteborg, emissions to air are not measured and could therefore not be reported in this study. The steel used for the rings are 100 % made from scrap and is not seen as a resource, but comes from the technosphere.. The steel scrap from the process at SKF, Göteborg is sent to Ovako Steel in Hofors for recycling and is therefore not seen as waste, but a co-product to the technosphere.
Time Boundary	The data was collected during the autumn 2002.
Geographical Boundary	The production of bearing steel, the hot rolling of ingot and the production of steel rings take place at Ovako Steel AB in Hofors, Sweden. The forging of ingot into steel bars, 350 mm, takes place at Scana Steel Söderfors AB in Söderfors, Sweden. The ringprocesses at SKF takes place in Göteborg, Sweden.
Other Boundaries	All production of electricity and other energy sources are included in this dataset. Average swedish electricity production has been used. In the activity ring processes at SKFs site in Göteborg, internal transport within SKF Industrial Area in Göteborg in included (1 km electric truck). BeTe Truck AB in Sweden has estimated the consumption of an electric truck: 0,75 kWh/km. The electricity production is included for all activities and is calculated as Swedish average electricity. The transports included are further described under ''function''. The production of electricity

	and diesel are included. The mineral oil in the cutting fluid (used at SKFs site in Göteborg) has been traced back to its cradle. The cutting fluid is an emulsion consisting of 4 % Castrol SW 3420. Castrol SW 3420 consists of 40% mineral oil according to the product data sheet (Castrol SW 3420). The amount of mineral oil has been accounted for. The activities ''Extraction of crude oil'' and ''Refining of crude oil'' have been used from SPINE@CPM. The mineral oil in the emulsion has also been traced to its grave. It is separated from the water content and burnt in Halmstad and used as energy source for the cement industry. The activity used is ''Combustion of waste''. It can also be found in SPINE@CPM database.
Allocations	Allocations have been made according to weight and production. For the activity 1-4 it is only allocated according to weight. For the process steps at SKFs site in Göteborg, energy consumption depends on how long the rings are processed in the different process equipment. This varies according to weight, but also according to size and desired properties of the final product. The cutting fluid used in the process is allocated according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	European average
Method	Most of the data has been gathered from interviews with the production managers at the different sites. This is more detailed described under each subactivity.
Literature Reference	Miljörapport Hydro Agri AB Köping, (1998). Official environmental report. Hydro Agri AB, Box 908, 731 29 Köping. Personal communication: Andersson B (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27834. Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Karlsson L-H (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27800
Notes	Energy flow data are confidential. Energy consumption/production from the preceeding nitric acid production step is included in these energy figures. Emissions of nitrogen to water also include contribution from production of nitric acid.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Surface water	537.2			kg	Water	
	Input	Refined resource	Al	2.154			kg	Ground	
	Input	Refined resource	Alumet	4.102			kg	Technosphere	
	Input	Refined resource	Bentonite	0.01244			kg	Ground	
	Input	Refined resource	Biomass	23.04			kg	Ground	
	Input	Refined resource	Brick	0.4141			kg	Technosphere	
	Input	Refined resource	Carbon	33.37			kg	Ground	
	Input	Refined resource	Copper in ore	0.01795			kg	Ground	
	Input	Refined resource	Crude oil	0.6419			MJ	Technosphere	
	Input	Refined resource	Crude oil	457.4			kg	Ground	
	Input	Refined resource	Dolomite	0.1316			kg	Technosphere	
	Input	Refined resource	Electrode	5.016			kg	Technosphere	
	Input	Refined resource	Emulsion	2.609			kg	Technosphere	
	Input	Refined resource	Ferro Molybdenum (FeMo)	1.033			kg	Technosphere	
	Input	Refined resource	Ferro Sulphur (FeS)	0.3984			kg	Technosphere	

	Input	Refined resource	Ferroboron (FeB)	0.000959			kg	Technosphere	
	Input	Refined resource	Ferrochromium (FeCr)	20.51			kg	Technosphere	
	Input	Refined resource	Ferromanganese in ore	5.651			kg	Technosphere	
	Input	Refined resource	Ferroniobium (FeNb)	0.00177			kg	Technosphere	
	Input	Refined resource	Ferrosilicon (FeSi)	6.285			kg	Technosphere	
	Input	Refined resource	Ferrotitanium (FeTi)	0.005902			kg	Technosphere	
	Input	Refined resource	Ferrovanadium (FeV)	0.1033			kg	Technosphere	
	Input	Refined resource	Grease	0.256			kg	Technosphere	
	Input	Refined resource	Hard coal	31.83			kg	Ground	
	Input	Refined resource	Hydraulic Oil	0.0005659			m3	Technosphere	
	Input	Refined resource	Hydraulic Oil	1.109			kg	Technosphere	
	Input	Refined resource	Hydro power	4390			MJ	Ground	
	Input	Refined resource	Ingot Mould	14.9			kg	Technosphere	
	Input	Refined resource	Iron in ore	0.08859			kg	Ground	
	Input	Refined resource	Lead in ore	0.000319			kg	Ground	
	Input	Refined resource	Lignite	9.789			kg	Ground	
	Input	Refined resource	Lime	0.12			kg	Technosphere	
	Input	Refined resource	Lime	40.99			kg	Ground	
	Input	Refined resource	Lubricating Oil	0.0001884			m3	Technosphere	
	Input	Refined resource	Lubricating Oil	0.254			kg	Technosphere	
	Input	Refined resource	Merchant Scrap	1067			kg	Technosphere	
	Input	Refined resource	Metal Ribbon	1.962			kg	Technosphere	
	Input	Refined resource	Methanol	3.512			kg	Technosphere	
	Input	Refined resource	Municipal water	104.8			kg	Technosphere	
	Input	Refined resource	N2	61.5			kg	Technosphere	
	Input	Refined resource	Natural gas	20.61			kg	Ground	
	Input	Refined resource	Ni	1.475			kg	Ground	
	Input	Refined resource	Olivine	9.698			kg	Ground	
	Input	Refined resource	Oxygen	76.15			kg	Technosphere	
	Input	Refined resource	Potassium nitrate	2.384			kg	Technosphere	
	Input	Refined resource	Propane	0.5294			kg	Technosphere	
	Input	Refined resource	Refractory Lining	16.08			kg	Technosphere	
	Input	Refined resource	Saw Blade	0.08081			kg	Technosphere	
	Input	Refined resource	Sodium nitrite	2.384			kg	Technosphere	
	Input	Refined resource	Steam	60.49			kg	Technosphere	
	Input	Refined resource	Steel scrap	568.4			kg	Technosphere	
	Input	Refined resource	Sulphuric acid	0.2008			kg	Technosphere	

	Input	Refined resource	Teeming Channel Bricks	6.27			kg	Technosphere	
	Input	Refined resource	Thermal energy	0.2541			MJ	Technosphere	
	Input	Refined resource	Tools	3.833			kg	Technosphere	
	Input	Refined resource	Uranium in ore	0.03407			kg	Ground	
	Input	Refined resource	Water	85.42			kg	Water	
	Input	Refined resource	Wind power	9.331			MJ	Ground	
	Input	Refined resource	Wood	0.00529			kg	Ground	
	Input	Refined resource	Wood Packing	51.95			kg	Technosphere	
	Output	Co-product	Drinking Water	84.98			kg	Technosphere	
	Output	Co-product	Gasoline	35.04			MJ	Technosphere	
	Output	Co-product	Recycled steel	411.4			kg	Technosphere	
	Output	Co-product	Steel scrap	131.8			kg	Technosphere	
	Output	Emission	Al	0.0001688			kg	Water	
	Output	Emission	Aromatics	7.712e-008			kg	Water	
	Output	Emission	As	1.178e-005			kg	Air	
	Output	Emission	As	4.961e-005			kg	Water	
	Output	Emission	Benzene	0.01173			kg	Air	
	Output	Emission	BOD5	2.446e-005			kg	Water	
	Output	Emission	BOD-7	2.044e-006			kg	Water	
	Output	Emission	Cd	2.413e-005			kg	Air	
	Output	Emission	Cd	2.41e-005			kg	Water	
	Output	Emission	Cl-	11.86			kg	Water	
	Output	Emission	CN-	0.0001175			kg	Air	
	Output	Emission	CN-	1.297e-006			kg	Water	
	Output	Emission	CO	2.876			kg	Air	
	Output	Emission	Co	3.31e-007			kg	Water	
	Output	Emission	CO2	1372			kg	Air	
	Output	Emission	COD	0.0008246			kg	Water	
	Output	Emission	Cr	1.854e-007			kg	Air	
	Output	Emission	Cr	4.077e-006			kg	Water	
	Output	Emission	Cr3+	0.0003553			kg	Water	
	Output	Emission	Cr3+	1.977e-005			kg	Air	
	Output	Emission	Cu	1.341e-006			kg	Water	
	Output	Emission	Cyanide	3.872e-009			kg	Water	
	Output	Emission	Dioxin	1.758e-009			kg	Air	
	Output	Emission	Dioxin (TCDD)	1.918e-009			kg	Air	
	Output	Emission	Dissolved solids	0.01271			kg	Water	
	Output	Emission	Emulsion	2.609			kg	Water	
	Output	Emission	F-	0.004913			kg	Water	
	Output	Emission	H2	0.3632			kg	Air	
	Output	Emission	H2S	4.25e-008			kg	Water	
	Output	Emission	H2S	8.874e-005			kg	Air	
	Output	Emission	HC	0.0001134			kg	Air	
	Output	Emission	HCl	0.00591			kg	Air	
	Output	Emission	HF	0.00625			kg	Air	
	Output	Emission	Hg	2.64e-006			kg	Air	
	Output	Emission	Hg	7.728e-012			kg	Water	
	Output	Emission	Hydrocarbons	0.004799			kg	Air	
	Output	Emission	Methane	1.906			kg	Air	
	Output	Emission	N total	0.04663			kg	Water	
	Output	Emission	N2	55.83			kg	Air	
	Output	Emission	N2O	0.003666			kg	Air	
	Output	Emission	NH3	0.0001668			kg	Air	
	Output	Emission	NH3	6.043e-007			kg	Water	
	Output	Emission	Ni	0.0001481			kg	Water	
	Output	Emission	Ni	0.0008979			kg	Air	
	Output	Emission	NMVOC	0.04271			kg	Air	
	Output	Emission	NMVOC, oil combustion	3.434			kg	Air	

	Output	Emission	NOx	4.763			kg	Air	
	Output	Emission	N-tot	2.627e-006			kg	Water	
	Output	Emission	Oil	0.402			kg	Water	
	Output	Emission	Other organics	0.309			kg	Water	
	Output	Emission	PAH	8.673e-010			kg	Air	
	Output	Emission	Particles	40.45			kg	Air	
	Output	Emission	Particulates	5.344e-006			kg	Air	
	Output	Emission	Pb	0.0001805			kg	Water	
	Output	Emission	Pb	7.853e-005			kg	Air	
	Output	Emission	Phenol	7.712e-009			kg	Water	
	Output	Emission	PO43-	0.001202			kg	Water	
	Output	Emission	Potassium nitrate	0.5372			kg	Water	
	Output	Emission	P-tot	4.256e-008			kg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	1.563e+009			Bq	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	1.663e+011			Bq	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Rn-222	1.244e+008			Bq	Air	
	Output	Emission	Sb	4.641e-009			kg	Water	
	Output	Emission	Sn	0.0003638			kg	Water	
	Output	Emission	SO2	2.051			kg	Air	
	Output	Emission	SO42-	0.4607			kg	Water	
	Output	Emission	Sodium nitrite	0.5372			kg	Water	
	Output	Emission	Sulphur	0.4958			kg	Air	
	Output	Emission	Susp solids	2.314e-006			kg	Water	
	Output	Emission	V	1.021e-010			kg	Air	
	Output	Emission	V	1.093e-006			kg	Water	
	Output	Emission	VOC	0.03886			kg	Air	
	Output	Emission	Zn	4.585e-006			kg	Water	
	Output	Product	Bearing rings	743			kg	Technosphere	
	Output	Residue	Demolition	0.08388			kg	Technosphere	
	Output	Residue	Grease	0.1616			kg	Technosphere	
	Output	Residue	Grindings	33.92			kg	Technosphere	
	Output	Residue	Hazardous	0.4524			kg	Technosphere	
	Output	Residue	Highly radioactive	0.05476			kg	Technosphere	
	Output	Residue	Hydraulic Oil	1.108			kg	Technosphere	
	Output	Residue	Industrial	45.23			kg	Technosphere	
	Output	Residue	Ingot Mould	14.9			kg	Technosphere	
	Output	Residue	Lubricating Oil	0.254			kg	Technosphere	
	Output	Residue	Metal Ribbon	1.962			kg	Technosphere	
	Output	Residue	Olivine	9.698			kg	Technosphere	
	Output	Residue	Other	132.5			kg	Technosphere	
	Output	Residue	Oxide scale	32.2			kg	Technosphere	
	Output	Residue	Particles	25.85			kg	Technosphere	
	Output	Residue	Pit Furnace Slag	55.87			kg	Technosphere	
	Output	Residue	Radioactive	0.002081			kg	Technosphere	
	Output	Residue	Refractory Lining	16.08			kg	Technosphere	
	Output	Residue	Sludge	3.908			kg	Technosphere	
	Output	Residue	Steel scrap	67.33			kg	Technosphere	
	Output	Residue	Teeming Channel Bricks	6.279			kg	Technosphere	
	Output	Residue	Tools	3.833			kg	Technosphere	
	Output	Residue	Waste water	537.2			kg	Water	
	Output	Residue	Water	19.2			kg	Water	
	Output	Residue	Wood Packing	17.32			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valild for production of bearing rings of the same material and weight, produced in the same way and at the same locations since the tranportation between the sites also are included in this dataset The data can be used (together with data for the other ingoing components) to calculate environmental impact for a complete spherical roller bearing 232/530. The activities for the production of the other ingoing components are also available at SPINE@CPM: * Production of bearing rollers (á 9.2 kg) * Production of brass cages used for spherical roller bearings * Production of guide rings used for spherical roller bearings and the activity for the production of a complete SRB 232/530 can be found as: * Production of SKF Spherical Roller Bearing 232/530
About Data	Data is gathered from interviews with Eva-Maria Arvidsson at Ovako Steel AB in Hofors, Sweden, Leif Hedström at Scana Steel AB in Söderfors, Sweden, Thomas Lundberg and Janne Bertilsson at SKF Large Bearings AB in Göteborg. Some data is obtained from existing databases (SPINE@CPM database) The energy and transport database from CIT Ekologik AB, 2002, has been used for average swedish electricity production data.
Notes	

SPINE LCI dataset: Production of bearing rollers (à 9,2 kg)

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Production of bearing rollers (à 9,2 kg)
Functional Unit	One bearing roller, 9.2 kg
Functional Unit Explanation	One spherical roller bearing 232/530 consists of following components: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 rollers (coated or non-coated) The functional unit for this process is ONE roller. The data can be used (together with data for the other ingoing components) to calculate environmental impact for a complete

	spherical roller bearing 232/530. The activities for the production of the other ingoing components are also available at SPINE@CPM: * Production of bearing rings * Production of brass cages used for spherical roller bearings * Production of guide rings used for spherical roller bearings and the activity for the production of a complete SRB 232/530 can be found as: * Production of SKF Spherical Roller Bearing 232/530 Dimensions of the bearing 232/530: di= 530 mm dy= 980 mm breadth= 355 mm
Process Type	Cradle to gate
Site	SKF Large Bearings
Sector	Materials and components
Owner	SKF Large Bearings
Technical system description	This activity describes production of bearing rollers (à 9,2 kg). 36 bearing rollers of this type are needed for one SKF spherical roller bearing 232/530. The bearing rollers are mounted into SKF spherical roller bearing 232/530. The bearing rollers are made from steel bars, 117 mm. The steel bars, produced at the Stockbridge Works in Sheffield by Corus Engineering Steels, are transported from Sheffield in England to Kode in Sweden for cutting and then finally to SKF in Göteborg for further processing into rollers. The following process steps are included in this dataset: 1. Cutting of steel bars (117 x 147 mm) 2. Turning of steel bars into bearing rollers 3. Transport E Factory - C Factory 4. Hardening of bearing rollers. 5. Transport C Factory - E Factory 6. Grinding of bearing rollers. 7. Handpolishing of bearing rollers. 8. Production of grinding paper. Process step 1,2,6 and 7 are documented according to SPINE and can be found in the SPINE@CPM database. The steel scrap is sent to Ovako Steel AB in Hofors, Sweden, for recycling. Also the train transport from Göteborg to Hofors are included in the dataset. As a first process step at SKF, the rollers are turned in the SMT lathe into desired shape. The steel scrap is sent to Ovako Steel AB, Hofors, for recycling. The rollers are then sent to the (hardening) heat treatment. The heat treatment is located in another factory within the SKF Gothenburg industrial area. The data set for the heat treatment is obtained from an earlier LCA study of medium-sized bearings performed by Åsa Ekdahl and is available at SPINE@CPM, LCI database: ''Heat treatment of bearing rings''. The only difference in the heat treatment for rings and rollers is that the rollers are hardened to martensite. This treatment does not demand as high temperatures and long holding times as for hardening to a bainitic structure. The rollers are heated to 845°C and are then quenched to 170°C in the salt bath. Another difference is that the rollers must be cooled very slowly to room temperature before they are tempered into the new structure at 220°C in the last salt bath. After the heat treatment the rollers are transported back to the E-factory and all sides of the rollers are ground and hand polished. The production of grinding paper is accounted for in this dataset and approximated with the activity ''Production of Kraftliner'' from SPINE@CPM database. The transport from Västervik (Slipnaxos AB) where the grinding paper is manufactured is NOT included. The last step before packing is inspection of material quality by ultra sound. Also the diameter of the rollers is inspected. A standard deviation of roller diameter of more than 5 mm is not allowed. The rollers for the non-coated bearing are now ready for assembling. The rollers for the coated bearings are sent to Halmstad for coating. For further infomation Round billets, 125 mm, are produced from the steel ingot at the rolling mill in Sheffield. No data was available for these activities, but they can be approximated with other similar datasets from SPINE@CPM database:. ''Production of clean bearing steel'' and '' Manufacturing of Hot Rolled square billets, 150 mm'' These activities are NOT included in this dataset.

System Boundaries	
Nature Boundary	Emissions to air are NOT measured for the process steps: * Cutting of steel bars (117x147 mm) * Turning of steel bars into bearing rollers * Grinding of bearing rollers * Handpolishing of bearing rollers and could therefore not be reported in this study. For all other steps the emissions to air are included. Emissions to water and the use of cutting fluid at SKF, Göteborg, could according to allocation difficulties and lack of time not be calculated. The steel used for the rollers are 100 % made from scrap and is not seen as a resource, but comes from the technosphere. The steel scrap from the process at SKF, Göteborg is sent to Ovako Steel in Hofors for recycling and is therefore not seen as waste, but a co-product to the technosphere.
Time Boundary	The data was collected during the autumn 2002.
Geographical Boundary	All processes take place in Sweden. The cutting of the steel bars takes place in Kode, Sweden, and the other process steps are site specific for SKF in Göteborg, Sweden.
Other Boundaries	Internal transport within SKF Industrial Area in Göteborg in included (2 km electric truck) BeTe Truck AB in Sweden has estimated the consumption of an electric truck: 0,75 kWh/km. For the cutting of steel bars (117x147 mm) internal transport with diesel truck is included (15 s). Assumptions were made at BeTe Trucks AB in Sweden how much energy a dieseltruck consume per hour (=6 litres/h (average value)). The heating value for diesel (=35, 31 MJ/litre) was found at Internet: www.fast-tech.com and the diesel consumption could be calculated to 0,88275 MJ/15 s. The diesel production is included in the dataset. The electricity production is included for all activities and is calculated as Swedish average Electricity. The production of grinding paper are approximated with production of Kraftliner (data obtained from SPINE@CPM database). The production of grinding paper takes place in Västervik, Sweden, but the transport from Göteborg to Västervik is not included in this dataset. The steel scrap from the process at SKF, Göteborg, is tranported by train to Ovako Steel in Hofors. This tranport is also included in the study.
Allocations	Allocations have been made according to weight and production. Energy consumption depends on how long the rollers is processed in the different process equipment. This varies according to weight, but also according to size and desired properties of the final product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData	
Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	European average
Method	Data is gathered from interviews with Niclas Thim, SKF Large Bearings, Sweden and with Lars Andersson, Corus Group Sweden AB. See under each sub activity for more detailed information.
Literature Reference	Miljörapport Hydro Agri AB Köping, (1998). Official environmental report. Hydro Agri AB, Box 908, 731 29 Köping. Personal communication: Andersson B (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27834. Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Karlsson L-H (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27800
Notes	Energy flow data are confidential. Energy consumption/production from the preceeding nitric acid production step is included in these energy figures. Emissions of nitrogen to water also include contribution from production of nitric acid.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Iron in ore	0.0003904			kg	Ground	
	Input	Natural resource	Lead in ore	1.406e-006			kg	Ground	
	Input	Natural resource	Surface water	7.158			kg	Water	
	Input	Natural resource	Uranium in ore	0.0001469			kg	Ground	

		Input	Natural resource	Wood	2.304e-005			kg	Ground	
		Input	Refined resource	Al2(SO4)3	0.0003283			kg	Technosphere	
		Input	Refined resource	Bark	0.03185			MJ	Technosphere	
		Input	Refined resource	Bentonite	5.481e-005			kg	Ground	
		Input	Refined resource	biocides	3.92e-006			kg	Technosphere	
		Input	Refined resource	Biomass	0.09949			kg	Ground	
		Input	Refined resource	Board	2.45e-006			kg	Technosphere	
		Input	Refined resource	CaCO3	0.0001421			kg	Technosphere	
		Input	Refined resource	CaO	0.0002009			kg	Technosphere	
		Input	Refined resource	Copper in ore	7.909e-005			kg	Ground	
		Input	Refined resource	Core and core plug	9.359e-005			kg	Technosphere	
		Input	Refined resource	Crude oil	0.1114			kg	Ground	
		Input	Refined resource	Defoamers	4.655e-005			kg	Technosphere	
		Input	Refined resource	grinding plates	0.0004			m	Technosphere	
		Input	Refined resource	H2SO4	0.0007203			kg	Technosphere	
		Input	Refined resource	Hard coal	0.09588			kg	Ground	
		Input	Refined resource	Hardwood	0.00343			kg	Ground	
		Input	Refined resource	Hydro power	19.34			MJ	Ground	
		Input	Refined resource	Hydrochloric acid	3.43e-006			kg	Technosphere	
		Input	Refined resource	Lignite	0.001188			kg	Ground	
		Input	Refined resource	Lime	0.0005286			kg	Technosphere	
		Input	Refined resource	Lubricant	8.82e-006			kg	Technosphere	
		Input	Refined resource	Methanol	0.04679			kg	Technosphere	
		Input	Refined resource	N2	0.8194			kg	Technosphere	
		Input	Refined resource	Na2CO3	9.31e-005			kg	Technosphere	
		Input	Refined resource	Na2SO4	9.31e-005			kg	Technosphere	
		Input	Refined resource	NaOH	0.0004557			kg	Technosphere	
		Input	Refined resource	Natural gas	0.0107			kg	Ground	
		Input	Refined resource	Oxygen	0.006186			kg	Technosphere	
		Input	Refined resource	Peat	0.00294			MJ	Technosphere	
		Input	Refined resource	Pitch despergent	9.8e-007			kg	Technosphere	
		Input	Refined resource	Potassium nitrate	0.03178			kg	Technosphere	
		Input	Refined resource	Propane	0.00705			kg	Technosphere	
		Input	Refined resource	Retention aids	2.793e-005			kg	Technosphere	
		Input	Refined resource	S	8.33e-006			kg	Technosphere	
		Input	Refined resource	Sizing agents	7.84e-005			kg	Technosphere	
		Input	Refined resource	Sodium nitrite	0.03178			kg	Technosphere	

	Input	Refined resource	Softwood	0.05929			kg	Ground	
	Input	Refined resource	Starch	0.0002058			kg	Technosphere	
	Input	Refined resource	Steel	2.45e-006			kg	Technosphere	
	Input	Refined resource	Steel bar	12.6			kg	Technosphere	
	Input	Refined resource	Steel scrap	0.96			kg	Technosphere	
	Input	Refined resource	Sulphuric acid	0.0008849			kg	Technosphere	
	Input	Refined resource	Waste paper	0.01127			kg	Technosphere	
	Input	Refined resource	Wind power	0.04111			MJ	Ground	
	Output	Co-product	Electricity	0.000343			MJ	Technosphere	
	Output	Co-product	Recycled steel	3.2			kg	Technosphere	
	Output	Co-product	Tall oil	0.001225			kg	Technosphere	
	Output	Co-product	Thermal energy	0.01568			MJ	Technosphere	
	Output	Co-product	Turpentine	6.37e-005			kg	Technosphere	
	Output	Emission	Al	7.349e-007			kg	Water	
	Output	Emission	As	2.668e-009			kg	Water	
	Output	Emission	As	4.831e-010			kg	Air	
	Output	Emission	Benzene	6.534e-008			kg	Air	
	Output	Emission	BOD	0.0003283			kg	Water	
	Output	Emission	BOD5	1.065e-007			kg	Water	
	Output	Emission	Cd	1.462e-009			kg	Water	
	Output	Emission	Cd	9.53e-010			kg	Air	
	Output	Emission	Cl-	0.0007			kg	Water	
	Output	Emission	CN-	5.646e-009			kg	Water	
	Output	Emission	CN-	6.607e-010			kg	Air	
	Output	Emission	CO	0.03397			kg	Air	
	Output	Emission	Co	1.439e-009			kg	Water	
	Output	Emission	CO2	0.5803			kg	Air	
	Output	Emission	COD	0.0008512			kg	Water	
	Output	Emission	Cr	1.776e-008			kg	Water	
	Output	Emission	Cr	8.069e-010			kg	Air	
	Output	Emission	Cr3+	1.101e-010			kg	Air	
	Output	Emission	Cr3+	1.979e-009			kg	Water	
	Output	Emission	Cu	5.838e-009			kg	Water	
	Output	Emission	Dioxin	8.965e-014			kg	Air	
	Output	Emission	Dissolved solids	5.599e-005			kg	Water	
	Output	Emission	Dust	7.84e-005			kg	Air	
	Output	Emission	F-	5.41e-008			kg	Water	
	Output	Emission	H2	0.00484			kg	Air	
	Output	Emission	H2S	1.849e-010			kg	Water	
	Output	Emission	H2S	6.865e-006			kg	Air	
	Output	Emission	HCl	2.576e-007			kg	Air	
	Output	Emission	HF	5.888e-008			kg	Air	
	Output	Emission	Hg	1.147e-010			kg	Air	
	Output	Emission	Methane	0.0008074			kg	Air	
	Output	Emission	N total	1.109e-005			kg	Water	
	Output	Emission	N2	0.7439			kg	Air	
	Output	Emission	N2O	9.741e-007			kg	Air	
	Output	Emission	NH3	1.499e-008			kg	Air	
	Output	Emission	NH3	2.662e-009			kg	Water	
	Output	Emission	Ni	4.339e-008			kg	Air	
	Output	Emission	Ni	8.011e-009			kg	Water	
	Output	Emission	NMVOC	0.0001858			kg	Air	
	Output	Emission	NMVOC, natural gas combustion	8.663e-008			kg	Air	
	Output	Emission	NMVOC, oil combustion	1.913e-005			kg	Air	
	Output	Emission	NOx	0.000899			kg	Air	
	Output	Emission	Oil	2.402e-005			kg	Water	
	Output	Emission	Other organics	1.982e-005			kg	Water	

	Output	Emission	PAH	3.821e-012			kg	Air	
	Output	Emission	Particles	0.0001531			kg	Air	
	Output	Emission	Pb	1.028e-008			kg	Water	
	Output	Emission	Pb	3.785e-009			kg	Air	
	Output	Emission	PO43-	6.291e-008			kg	Water	
	Output	Emission	Potassium nitrate	0.007158			kg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	6.835e+005			Bq	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	7.273e+007			Bq	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Rn-222	5.481e+005			Bq	Air	
	Output	Emission	Sb	2.022e-011			kg	Water	
	Output	Emission	Sn	1.585e-006			kg	Water	
	Output	Emission	SO2	0.0005811			kg	Air	
	Output	Emission	SO42-	2.758e-005			kg	Water	
	Output	Emission	Sodium nitrite	0.007158			kg	Water	
	Output	Emission	SOx	4.214e-005			kg	Air	
	Output	Emission	Susp solids	0.0001225			kg	Water	
	Output	Emission	V	4.736e-009			kg	Water	
	Output	Emission	VOC	0.0001535			kg	Air	
	Output	Emission	Zn	1.995e-008			kg	Water	
	Output	Product	bearing roller	9.2			kg	Technosphere	
	Output	Residue	Ashes	0.0002107			kg	Technosphere	
	Output	Residue	Demolition	0.0003696			kg	Technosphere	
	Output	Residue	Hazardous	0.0004135			kg	Technosphere	
	Output	Residue	Highly radioactive	0.0002413			kg	Technosphere	
	Output	Residue	Industrial	0.00574			kg	Technosphere	
	Output	Residue	Other	0.5838			kg	Technosphere	
	Output	Residue	Other rest products	0.0009702			kg	Technosphere	
	Output	Residue	Radioactive	1.159e-008			kg	Technosphere	
	Output	Residue	Steel scrap	0.2			kg	Technosphere	
	Output	Residue	Waste water	7.158			kg	Water	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valild for bearing rollers of the same material and weight and with the same processing steps at the manufacturing. The data can be used (together with data for the other ingoing components) to calculate environmental impact for a complete spherical roller bearing 232/530. The activities for the production of the other ingoing components are also available at

	SPINE@CPM: * Production of bearing rings * Production of brass cages used for spherical roller bearings * Production of guide rings used for spherical roller bearings and the activity for the production of a complete SRB 232/530 can be found as: * Production of SKF Spherical Roller Bearing 232/530
About Data	Data is gathered from interviews with Niclas Thim, SKF Large Bearings, Sweden and with Lars Andersson, Corus Group Sweden AB. Data from the cutting process in Kode is obtained from the product manager in Kode and from Niclas Thim.
Notes	

SPINE LCI dataset: Production of Bearing Steel

Administrative	
Finished	Y
Date Completed	2000-01-17
Copyright	
Availability	Public

Technical System	
Name	Production of Bearing Steel
Functional Unit	one ton of produced bearing steel
Functional Unit Explanation	The bearing steel quality is SKF3, 100Cr6.
Process Type	Cradle to gate
Site	Steel Mill Ovako Steel AB 813 82 Hofors Sweden
Sector	Materials and components
Owner	Steel Mill Ovako Steel AB 813 82 Hofors Sweden
Technical system description	These are the process steps included in the data set: 1. Melting 2. Deslagging 3. Ladle Furnace Treatment 4. Degassing 5. Ingot Teeming 6. Stripping The bearing steel is produced completely from scrap which is melted in an electric arc furnace. The steel is teemed to ingots weighing 4200 kg each. The quality of the steel is SKF3, 100Cr6.

System Boundaries	
Nature Boundary	Emissions to air are considered. Emissions to soil are not considered. Emissions to water are not considered.
Time Boundary	The data are based on the production in 1998. The bricks used in the ladle furnace is from 1999 sent back to the producer for recycling. In 2000 the olivine is recycled.
Geographical Boundary	The Steel Mill is located in Hofors, Sweden.
Other Boundaries	Production of raw material is not included. Production of electricity is not included. Waste treatment is not included. Subsystems concearning employees are not included. Transports are not included.

Allocations	No allocations have been necessary. The data are simply divided by the total tons produced in 1998. This is because all the processes are the same no matter what steel type is produced.
Systems Expansions	not relevant

Flow Data

General Activity QMetaData

Date Conceived	1998-01-01
Data Type	Derived, unspecified
Represents	European average
Method	The data are from Ovako's purchase register and environmental report. It has been divided by the steel (in tons) produced in 1998.The data have not been allocated since all processes are used for every steel type.
Literature Reference	Ovako Steel internal information system
Notes	Energy flow data are confidential. Energy consumption/production from the preceeding nitric acid production step is included in these energy figures. Emissions of nitrogen to water also include contribution from production of nitric acid.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: Ovako Steel internal information system Notes: Drinking water used in the process.	Input	Natural resource	Municipal water	0.11			m3	Ground water	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: The water is taken from Hoån.	Input	Natural resource	Surface water	33.71			m3	River	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, continuous Method: weighting Literature: Ovako Steel internal information system Notes: Aluminium bar: 1 kg Aluminium wire: 0.27 kg	Input	Refined resource	Aluminium	1.27			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	Anthracite	14			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Method: calculated Literature: Ovako Steel internal information system Notes: This is total bricks used in the steel mill which include: kiln bricks: 0.77 kg taphole bricks: 0.027 kg ''centerpiece bricks'': 0.34 kg lining bricks: 2.87 kg coil bricks: 0.044 kg ''stigplanstegel'': 4.39 kg	Input	Refined resource	Brick	8.442			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: Carbon powder used to form slag in the electric arc furnace.	Input	Refined resource	Carbon black	170			g	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, continuous Literature: Ovako Steel internal information system Notes: The electrodes for the electric arc furnace are made of graphite produced in Europe.	Input	Refined resource	Carbon, graphite	3			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: Graphite powder.	Input	Refined resource	Carbon, graphite	5			kg	Technosphere	Sweden

Date concieved: 1998-01-01 Data type: Monitored data, continuous Literature: Ovako Steel internal information system Notes: Chromium 17 215: 14.16 kg Chromium 17 220: 1.03 kg	Input	Refined resource	Chromium	15.19			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: The clay is mixed with some of the olivine to form an olivinemass. Clay contenet 16%.	Input	Refined resource	Clay	0.49			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: Electric arc furnace: 486 kWh Ladle furnace: 28 kWh	Input	Refined resource	Electricity	514			kWh	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: For ingot teeming, made of steel.	Input	Refined resource	Ingot mould	11			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	Light fuel oil	0.71			l	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: Produced in Europe	Input	Refined resource	Limestone	38			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: Masses mostely containing magnesite. taphole: 0.28 kg ''slaggläpp'': 0.54 kg electric furnace: 2.32 kg ladle furnace: 0.49 kg stripping: 0.14 kg	Input	Refined resource	Magnesite	3.76			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: Taphole sand used in the electric arc furnace.	Input	Refined resource	Natural sand	3.58			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: At 21 degrees Celsius	Input	Refined resource	O2	30.457			m3	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: 2.58 kg is miwed with clay to form an olivine mass. The clay content is 16%.	Input	Refined resource	Olivine	7.57			tonne	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, continuous Literature: Ovako Steel internal information system Notes: Silicon 17 103	Input	Refined resource	Silicon	4.68			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Input	Refined resource	Steam	41			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, continuous Method: weighting Literature: Ovako Steel internal information system Notes: This is total scrap which is made up by: pieces: 275 kg grindings: 108 kg steel sheets: 77 kg fragmentated scrap: 117 kg grinding dust: 10 kg reused scrap separated from the slag: 58 kg commercial iron: 422 kg	Input	Refined resource	Steel scrap	1067			kg	Technosphere	Sweden

Date concieved: 1998-01-01 Data type: Derived, mixed Method: measurements after the filter at two different times the same day Literature: Ovako Steel internal information system	Output	Emission	Chlorinated benzenes	44			mg	Rural air	Sweden
Date concieved: 1998-01-01 Data type: Derived, mixed Method: measurements after the filter at two different times the same day Literature: Ovako Steel internal information system	Output	Emission	Chlorinated phenols	12			mg	Rural air	Sweden
Date concieved: 1998-01-01 Data type: Derived, mixed Method: measurements after the filter at two different times the same day. Literature: Ovako Steel internal information system Notes: The temperature of the gas is 97 degrees celsius.	Output	Emission	CO	0.41			m3	Rural air	Sweden
Date concieved: 1998-01-01 Data type: Derived, mixed Method: measurements after the filter at two different times the same day. Literature: Ovako Steel internal information system Notes: The temperature of the gas is 97 degrees celsius.	Output	Emission	CO2	50.36			m3	Rural air	Sweden
Date concieved: 1998-01-01 Data type: Derived, mixed Method: measurements after the filter at two different times the same day Literature: Ovako Steel internal information system	Output	Emission	Dioxine	2.5			ug	Rural air	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, discrete Method: measurements Literature: Ovako Steel internal information system	Output	Emission	Dust	156.1			g	Rural air	Sweden
Date concieved: 1998-01-01 Data type: Derived, mixed Method: measurements after the filter at two different times the same day Literature: Ovako Steel internal information system	Output	Emission	Hg	20.6			mg	Rural air	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Output	Emission	NOx	148			g	Rural air	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, continuous Method: weighting Literature: Ovako Steel internal information system Notes: The quality is SKF3, 100Cr6. The ingots weigh 4200 kg.	Output	Product	Steel ingot	1.00			tonne	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Output	Residue	Brick	8.442			kg	Landfill ground	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Output	Residue	Clay	0.49			kg	Landfill ground	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: Ovako Steel internal information system	Output	Residue	Dust	18.25			kg	Landfill ground	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: The ingot mould is transported back to the supplier for recycling.	Output	Residue	Ingot mould	11			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system	Output	Residue	Magnesite	3.76			kg	Landfill ground	Sweden

Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: In 2000 the olivine is recycled.	Output	Residue	Olivine	7.57			kg	Landfill ground	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Literature: Ovako Steel internal information system Notes: The slag contains (maximum values): Al2O3 CaO MgO V2O5 SiO2 FeO TiO2 S 70 22 13 2.5 1 1 0.1 0.1	Output	Residue	Slag	2			kg	Landfill ground	Sweden
Date concieved: 1998-01-01 Data type: Derived, unspecified Method: calculated Literature: Ovako Steel internal information system Notes: The contence of the slag is as follow: Si O2 MnO P2O5 Cr2O3 NiO MgO CuO V2O5 TiO2 Al2O3 13.99 5.86 0.4 3.65 0.03 3.79 0.04 0.31 0.5 6 FeO CaO K2O ZnO PbO C S CdO Cr(VI) Hg (ppm) 16.42 44.08 0.01 0.01 0.01 0.51 0.13 0.0005 0.0022 0.27	Output	Residue	Slag	98			kg	Landfill ground	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, continuous Literature: Ovako Steel internal information system	Output	Residue	Steel scrap	31.04			kg	Technosphere	Sweden
Date concieved: 1998-01-01 Data type: Monitored data, discrete Literature: Ovako Steel internal information system Notes: The process water is cleaned before it's let back to the river.	Output	Residue	Waste water	33.82			m3	River	Sweden

About Inventory

Publication	Master's thesis ''LCA on SKF's Spherical Roller Bearing 24024'' by Åsa Ekdahl, ESA-report 2001:1, Department of Environmental Systems Analysis (ESA), Chalmers University of Technology (ISSN 1400-9560) This report is available for download at ESAs web-site: http://www.esa.chalmers.se --- Data documented by: Åsa Ekdahl, M Sc. student at the dept. of Environmental Systems Analysis, Chalmers University of Technology and SKF Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 ---
Intended User	The intended users of this dat
General Purpose	The general purpose for this data inventory is to document data in a way suitable for LCA studies.
Detailed Purpose	The data are to be used in the study: ''LCA on SKF's Spherical Roller Bearing 24024''. The aim of the study is to descibe the environmental properties of the bearing as well as identify the processes contributing most to the environmental impact.
Commissioner	Patrik Lindroth - SKF Sverige AB SRB Medium D3s3 415 50 Göteborg .
Practitioner	Ola Stuffe - Ovako Steel AB 813 82 Hofors Sweden .
Reviewer	
Applicability	The data are applicable to the production of bearing steel (SKF3, 100Cr6) at the Steel Mill at Ovako Steel in Hofors, Sweden.
About Data	
Notes	The data have been collected by Ola Stuffe at Ovako Steel under the supervision of Åsa Ekdahl.

SPINE LCI dataset: Production of beef. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Production of beef. ESA-DBP
Functional Unit	1 kg of beef
Functional Unit Explanation	
Process Type	Gate to gate
Site	Swedish Meats, Örebro, Sweden
Sector	Crop and animal production, hunting etc.
Owner	Swedish Meats, Örebro, Sweden
Technical system description	Excerpt from the report, see 'Publication': ''The Swedish meat consumption is quite constant, about 25 kg beef and 36 kg pork per capita each year. Domestic production accounts for 58% (139 million kg) and 79% (295 million kg) of the beef and pork production respectively. The company participating in the study, Swedish Meats, is one of the biggest food companies in Sweden, producing 58% of the slaughtered meat consumed. The company offers slaughtering and refining of beef, lamb and pork. The production of meat affects the environment in many ways. As for eutrofication and acidification, the largest contributor is the handling of manure; either in storage or as fertiliser in agriculture. Here ammonia in the form of emissions from manure and nitrogen leakage from crop cultivation are the most important substances, for acidification and eutrofication respectively. The cultivation of crop for use as fodder in the animal production affects the environment in other ways also, as an example the production of 1 kg of pork requires 11 m2 of land, out of which 9 m2 in Europe and 1.5 m2 in South America, the latter mainly for soy cultivation. A cow emits about 120-130 kg methane annually, which corresponds to the global warming potential of the carbon dioxide emissions from an average car driven 12 600 km. This methane is formed by micro organisms in the cow's stomach when fodder is broken down and most of this is released through the cow's mouth. This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Pea-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Pea cultivation. ESA-DBP - Production of pork. ESA-DBP - Rape seed cultivation. ESA-DBP - Wheat cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean processing. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries	
Nature Boundary	Data include use of energy, as well as emissions to the air and water.
Time Boundary	The data come from the report which was completed in 2002.
Geographical Boundary	Excerpt from the report, see 'Publication': ''Most ingredients in the two animal-based products originate from Sweden.

Other Boundaries	Excerpt from the report, see 'Publication': ''Not included are any aspects regarding personnel. (...) Some ingredients in the food processes have been judged to contribute very little to the overall process, and have therefore been excluded.''
Allocations	No information about the allocation in the report.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from other report.
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf The particular data come from: Ahlmén K. (2002) LCA livsmedel, Maten och Miljön: Livscykelanalys av sju livsmedel. Sigill Kvalitetssystem AB, Stokholm, Sweden
Notes	Energy flow data are confidential. Energy consumption/production from the preceeding nitric acid production step is included in these energy figures. Emissions of nitrogen to water also include contribution from production of nitric acid.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Avoided production of district heating from use of waste	Input	Refined resource	District heating	-1.20E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity	7.80E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Fossil fuel	3.57E+01			MJ	Technosphere	Sweden
	Input	Refined resource	Renewable energy source	2.20E-01			MJ	Technosphere	Sweden
	Output	Emission	CH4	2.95E+02			g	Air	Sweden
	Output	Emission	CO2	2.86E+03			g	Air	Sweden
	Output	Emission	N2O	1.50E+01			g	Air	Sweden
	Output	Emission	NH3	1.38E+02			g	Air	Sweden
	Output	Emission	NOx	1.70E+01			g	Air	Sweden
	Output	Emission	N-tot	8.70E+01			g	Water	Sweden
	Output	Emission	P-tot	5.00E-01			g	Water	Sweden
	Output	Emission	SOx	7.40E+00			g	Air	Sweden
	Output	Product	Beef	1.00E+03			g	Other	Sweden

About Inventory

Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .

Practitioner	Anders Abelmann - Chalmers University of Technology.
Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The data for pork and beef used for a study were taken from a publication: Ahlmén K. (2002) LCA livsmedel, Maten och Miljön: Livscykelanalys av sju livsmedel. Sigill Kvalitetssystem AB, Stokholm, Sweden

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SPINE LCI dataset: Production of benzene (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of benzene (APME)
Functional Unit	1 kg benzene
Functional Unit Explanation	Typical uses for benzene is for styrene and ethyl benzene, cumene and phenol, cyclohexane, nitrobenzene and aniline, and detergent alkylate. Benzene can be extracted from pyrolysis gasoline through repeated distillation and directly from naphtha by a process known as catalytic reforming.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Production of benzene include all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. Most benzene is produced directly from naphtha by catalytic reforming, a process in which naphthenic compounds in naphtha are dehydrogenated. The basic feedstock is thus converted into a mixture of products, mainly benzene, toluene and xylene; hence, the process is often called the BTX process. Benzene and the other aromatics are isolated in the pure state form the output of the reformer by solvent extraction and fractional distillation. The output of benzene is maximised if the naphtha feed is rich in ring compounds containing 7 carbon atoms. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and deliver; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been tracked back to the extraction of raw materials from the earth.

	Operating conditions: As the data are based on information from 14 plants in 6 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. Although benzene is usually present in small quantities in crude oil, its direct extraction is usually uneconomic. However, one by-product of naphta cracking is a liquid usually referred to as pyrolysis gasoline which is high in unsaturated aliphatic and aromatic hydrocarbons. The benzene fraction in pyrolysis gasoline can be extracted by repeated distillation and it is thought that about half of all benzene used in Europe is produced in this way. Benzene is also produced directly from naphtha by a process known as catalytic reforming. This process leaves the number of carbon atoms in teh starting feedstock unchanged but the output mixture contains a higher number of double bonds and aromatic rings. The basic petroleum feedstock is converted into a mixture of products of which the principal components are benzene, toluene and xylene (the process is often referred to as the BTX process). Benzene and other aromatics are isolated in the pure state from the output of the reformer by solvent extraction and fractional distillation. The relative proportions of benzene derived from the two sources vary from one operator to another but, in the later calculations, when the precise mix is unknown - as for example, when benzene is purchased on the open market - it is assumed that 50% is derived from each source. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1989-1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 14 major benzene producers in Belgium, France, Germany Italy, Netherlands and UK. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Methodology report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 14 benzene production plants in 6 countries: Belgium, France, Germany, Italy, Netherlands and UK. Their total production was 3,2 million tonnes.

Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1989-1995
Data Type	Derived, mixed
Represents	See 'Function'
Method	European average data. Results are based on data supplied by 14 benzene production plants in 6 countries: Belgium, France, Germany, Italy, Netherlands and UK. Their total production was 3,2 million tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME - Association of Plastics Manufacturers in Europe, website: http://lca.apme.org
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Air	56864.78099			mg	Air	Europe

		Input	Natural resource	Bauxite	2.63E-02			mg	Ground	Europe
		Input	Natural resource	Bauxite	355.103554			mg	Ground	Europe
		Input	Natural resource	Bentonite	185.5996172			mg	Ground	Europe
		Input	Natural resource	Biomass	186.3396611			mg	Ground	Europe
		Input	Natural resource	Calcium sulphate	18.51496857			mg	Ground	Europe
		Input	Natural resource	Chalk	8.90E-24			mg	Ground	Europe
		Input	Natural resource	Chromium	7.86E-07			mg	Ground	Europe
		Input	Natural resource	Clay	17.13201673			mg	Ground	Europe
		Input	Natural resource	Crude oil	672063.9859			mg	Ground	Europe
		Input	Natural resource	Dolomite	7.527376955			mg	Ground	Europe
		Input	Natural resource	Fe	691.5115879			mg	Ground	Europe
		Input	Natural resource	Feldspar	1.30E-29			mg	Ground	Europe
		Input	Natural resource	Ferromanganese	0.550594241			mg	Ground	Europe
		Input	Natural resource	Fluorite	0.261348271			mg	Ground	Europe
		Input	Natural resource	Granite	3.30E-03			mg	Ground	Europe
		Input	Natural resource	Gravel	2.236570537			mg	Ground	Europe
		Input	Natural resource	Hard coal	14016.79539			mg	Ground	Europe
		Input	Natural resource	Hydro energy	2.10E-02			MJ	Ground	Europe
		Input	Natural resource	Lignite	1259.220077			mg	Ground	Europe
		Input	Natural resource	Limestone	745.4906687			mg	Ground	Europe
		Input	Natural resource	Metallurgical coal	245.2952473			mg	Ground	Europe
		Input	Natural resource	Natural gas	784440.9159			mg	Ground	Europe
		Input	Natural resource	Ni	1.51E-06			mg	Ground	Europe
		Input	Natural resource	Nitrogen	27131.31238			mg	Ground	Europe
		Input	Natural resource	Nuclear energy	0.210695247			MJ	Ground	Europe
		Input	Natural resource	Olivine	5.687044842			mg	Ground	Europe
		Input	Natural resource	Oxygen	20.64944692			mg	Ground	Europe
		Input	Natural resource	Pb	6.73E-02			mg	Ground	Europe
		Input	Natural resource	Peat	1.028067137			mg	Ground	Europe
		Input	Natural resource	Phosphate	9.15E-02			mg	Ground	Europe
		Input	Natural resource	Potassium chloride	1.298992333			mg	Ground	Europe
		Input	Natural resource	Rutile	1.28E-23			mg	Ground	Europe
		Input	Natural resource	Sand	105.3138539			mg	Ground	Europe
		Input	Natural resource	Shale oils	52.41587601			mg	Ground	Europe
		Input	Natural resource	Sodium chloride	898.4793263			mg	Ground	Europe
		Input	Natural resource	Sulphur	102.902071			mg	Ground	Europe
		Input	Natural resource	Sulphur (bonded)	30.91711346			mg	Ground	Europe

	Input	Natural resource	Water	123623454.4			mg	Water	Europe
	Input	Natural resource	Wood	0.975518321			mg	Ground	Europe
	Input	Natural resource	Zn	2.53E-03			mg	Ground	Europe
	Output	Co-product	Recovered energy	2.566680943			MJ	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	3.24E-08			mg	Air	Albania
	Output	Emission	1,2-Dichloroethane	6.48E-11			mg	Water	Albania
	Output	Emission	Acid as H+	30.684204			mg	Water	Europe
	Output	Emission	Al	16.0240977			mg	Water	Europe
	Output	Emission	Aldehydes	8.12E-04			mg	Air	Europe
	Output	Emission	As	5.29E-04			mg	Water	Europe
	Output	Emission	BOD5	27.9204354			mg	Water	Europe
	Output	Emission	Ca2+	0.88438681			mg	Water	Europe
	Output	Emission	CH4	5480.733927			mg	Air	Europe
	Output	Emission	Chloroorganics	1.17E-05			mg	Water	Europe
	Output	Emission	Chloroorganics	6.17E-02			mg	Air	Europe
	Output	Emission	Cl-	335.1410454			mg	Water	Europe
	Output	Emission	Cl2	1.94E-03			mg	Air	Europe
	Output	Emission	Cl2	2.18E-03			mg	Water	Europe
	Output	Emission	CN-	1.84E-02			mg	Water	Europe
	Output	Emission	CO	1469.85285			mg	Air	Europe
	Output	Emission	CO2	1399958.869			mg	Air	Europe
	Output	Emission	CO32-	178.5001637			mg	Water	Europe
	Output	Emission	COD	174.6373255			mg	Water	Europe
	Output	Emission	CrO3	9.46E-07			mg	Water	Europe
	Output	Emission	CS2	4.76E-04			mg	Air	Europe
	Output	Emission	Cu	2.88E-02			mg	Water	Europe
	Output	Emission	Dissolved organics	17.71454547			mg	Water	Europe
	Output	Emission	Dissolved solids	107.5587771			mg	Water	Europe
	Output	Emission	F-	2.30E-03			mg	Water	Europe
	Output	Emission	F2	4.96E-05			mg	Air	Europe
	Output	Emission	Fe	6.83E-02			mg	Water	Europe
	Output	Emission	H2	33.59167408			mg	Air	Europe
	Output	Emission	H2S	7.02E-02			mg	Air	Europe
	Output	Emission	H2SO4	3.32E-07			mg	Air	Europe
	Output	Emission	Halogenated hydrocarbons (chlorofluoroca	0.344876			mg	Air	Europe
	Output	Emission	HCl	6.088741219			mg	Air	Europe
	Output	Emission	HCN	4.36E-29			mg	Air	Europe
	Output	Emission	HF	0.228667441			mg	Air	Europe
	Output	Emission	Hg	1.18E-04			mg	Water	Europe
	Output	Emission	Hg	4.29E-03			mg	Air	Europe
	Output	Emission	K+	4.08E-02			mg	Water	Europe
	Output	Emission	Metals	2.120705839			mg	Air	Europe
	Output	Emission	Metals	248.0860265			mg	Water	Europe
	Output	Emission	Mg	1.49E-02			mg	Water	Europe
	Output	Emission	N total	4.647599284			mg	Water	Europe
	Output	Emission	Na	164.8483697			mg	Water	Europe
	Output	Emission	NH3	4.72E-04			mg	Air	Europe
	Output	Emission	NH4+	3.962335948			mg	Water	Europe
	Output	Emission	Ni	1.75E-02			mg	Water	Europe
	Output	Emission	NO	0.128094981			mg	Air	Europe
	Output	Emission	NO3-	4.334901013			mg	Water	Europe
	Output	Emission	NOx	6146.243516			mg	Air	Europe
	Output	Emission	Oil	5.53E+01			mg	Water	Europe
	Output	Emission	P2O5	0.371674095			mg	Water	Europe
	Output	Emission	Particles	641.1442527			mg	Air	Europe
	Output	Emission	Pb	1.98E-04			mg	Air	Europe
	Output	Emission	Pb	4.96E-04			mg	Water	Europe
	Output	Emission	Phenol	1.273257716			mg	Water	Europe
	Output	Emission	S2-	0.885531179			mg	Water	Europe
	Output	Emission	SO2	3973.499122			mg	Air	Europe
	Output	Emission	SO42-	267.6137793			mg	Water	Europe
	Output	Emission	Susp solids	174.7322923			mg	Water	Europe

	Output	Emission	Thiols	0.133889645			mg	Air	Europe
	Output	Emission	Vinyl chloride	1.66E-26			mg	Water	Andorra
	Output	Emission	Vinyl chloride	2.16E-08			mg	Air	Andorra
	Output	Emission	VOC	1.754777813			mg	Water	Europe
	Output	Emission	VOC	1436.762			mg	Air	Albania
	Output	Emission	VOC	40.14064			mg	Water	Europe
	Output	Emission	VOC	5.41E-01			mg	Air	Andorra
	Output	Emission	VOC	5.61E+01			mg	Air	Albania
	Output	Emission	Zn	7.65E-03			mg	Water	Europe
	Output	Product	Benzene	1			kg	Technosphere	Europe
	Output	Residue	Construction	30.5603981			mg	Ground	Europe
	Output	Residue	Industrial	840.7368798			mg	Ground	Europe
	Output	Residue	Inert chemical	524.7533086			mg	Ground	Europe
	Output	Residue	Metals	5.890547635			mg	Ground	Europe
	Output	Residue	Mineral	4578.338497			mg	Ground	Europe
	Output	Residue	Paper & board	4.54E-23			mg	Ground	Europe
	Output	Residue	Plastics	0.293545905			mg	Ground	Europe
	Output	Residue	Regulated chemical	483.0501213			mg	Ground	Europe
	Output	Residue	Slags & ashes	867.0614582			mg	Ground	Europe
	Output	Residue	To incinerator	370.834207			mg	Technosphere	Europe
	Output	Residue	To recycling	161.2495257			mg	Technosphere	Europe
	Output	Residue	Unspecified	21.52304446			mg	Ground	Europe
	Output	Residue	Wood waste	9.75E-03			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for benzene. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. --- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 27 November 2001 --- Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 ---
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .

Reviewer	-
Applicability	European average data. Results are based on data supplied by 14 benzene production plants in 6 countries: Belgium, France, Germany, Italy, Netherlands and UK. Their total production was 3,2 million tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for benzene production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of benzene in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Note that emissions <0,5 mg (0,25 mg in data table) may be far below 0,5 mg in some cases. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS

	Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni -- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 27 November 2001 <<< Changes made by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development A minor error in the documentation was corrected. The correction was made in ''About Data''.

SPINE LCI dataset: Production of Blister Copper

Administrative	
Finished	Y
Date Completed	1998
Copyright	The International Copper Association
Availability	Public

Technical System	
Name	Production of Blister Copper
Functional Unit	1 kg of Blister Copper
Functional Unit Explanation	The purity of copper is approximately 98.5%.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	Data received for this study are based on pyrometallurgical operations only. This activity includes: 1) Copper ore mining; 2) Copper ore concentrate preparation and delivery; 3) Production of matte copper and 4) Production of blister copper. Production and use of electricity and fuel used in the processes are included. Below is a description of the included operations. -- 1) Ore mining --

	The copper ore mining method used is determined by the size, shape and depth below the surface of the ore body. Most copper ores are mined by open pit mining in which large quarries are opened, the ore broken away from the deposits by use of explosives and shovelled into trucks. Actual energy requirements vary widely depending on the characteristics of the mine and ore handling techniques used. The type and the amount of ore deposit and the overlying rock and dirt and the depth of the seam below the surface, affect the level of energy needed for mining the ore. The data for copper mining have been received from three mining companies. The data cover the mining of 45 million tonnes of ore. -- 2) Ore concentrate preparation and delivery -- It is normal practice for mining companies to prepare or concentrate before shipping to reduce the amount of material to be transported. The data mainly relates to transportation of ore concentrate by rail and sea. Transporting the concentrate by sea is exstensive. It is assumed that average shipping and rail transport distances were 10 000 km and 500 km respectively. The data cover preparation of 2 million tonnes of concentrate -- 3) Production of matte copper -- Here the ore concentrate, mixed with flux and other additives, is charged in a fuelfired smelting furnace where it is melted. The molten mass is allowed to separate into two layers. The upper slag layer, made up of iron silicate with less than 0,5% of copper, is normally discarded. The lower matte layer, with about 40% to 75% of copper, and containing most of original metal present, is transferred to the converting step to produce blister copper. -- 4) Production of blister copper -- During the production of blister copper the matte is converted to blister in a converter by oxidation in two stages. In the first stage iron sulphide is oxidised and fluxed to form slag which may contain copper (1-5%). The converter slag is ususally recycled back to the smelting furnace. With all the iron removed, the remaining copper sulphide is further oxidised to blister copper.

System Boundaries

Nature Boundary	Some of the data on air and water emissions was provided in a form which made it impractical to calculate emissions for unit mass of product output. For example, from an air emission value given in the units of mg/m3 of air, it is not possible to calculate the total emission unless the total volume of air is known and this is seldom measured in pactice. Therefor, where available, only emission values associated with the given amount of product made are used.
Time Boundary	The data comes from mining companies and producers of primary copper for the operations during the 12 month period in 1995 (information why the year 1995 was chosen is not available).
Geographical Boundary	The data comes mainly from European operations. Futher information of the geographical boundaries is not available.
Other Boundaries	The copper producing industry is international.
Allocations	The first thing that has been done to analyse this system is to break down the complex system into a series of separate sub-systems each of which produces a single product but which, when added together, exhibit the same charateristics as the original single system. In this study has co-product allocation and Stoichiometric allocation been applied. It is not often that practical processes exactly match for example the stoichiometric rules and an alternative method using mass must be applied.
Systems Expansions	Not applied

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, unspecified
Represents	See 'Function'
Method	An LCA calculation of Blister Copper production. The tables that have been used are the tables 52, 54, 55, 56 and 57 in the Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998. For the following subjects has a slightly different name been use here in SPINE compaired from the original tables in the IAC report: In SPINE: In the IAC report: Iron Ore Iron Natural Gas Gas/Condensate NaCl Sodium Chloride HC Hydrocarbons CH4 Methane Cu Cu++/Cu+++ Calcium Ca++ NO3-N NO3- Hazardous waste Regulated chemical
Literature Reference	Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998.
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow

	with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Bauxite	25000			mg	Ground	
	Input	Natural resource	Bentonite	64			mg	Ground	
	Input	Natural resource	Calcium sulphate	1400			mg	Ground	
	Input	Natural resource	Coal	1032000			mg	Ground	
	Input	Natural resource	Crude oil	210000			mg	Ground	
	Input	Natural resource	Dolomite	1000			mg	Ground	
	Input	Natural resource	Iron ore	86000			mg	Ground	
	Input	Natural resource	Lead	3			mg	Ground	
	Input	Natural resource	Lignite	26000			mg	Ground	
	Input	Natural resource	Limestone	93000			mg	Ground	
	Input	Natural resource	NaCl	9700			mg	Ground	
	Input	Natural resource	Natural gas	92000			mg	Ground	
	Input	Natural resource	Nitrogen	540			mg	Ground	
Notes: Includes bonded and elemental sulphur.	Input	Natural resource	Sulphur	450			mg	Ground	
	Input	Natural resource	Wood	56000			mg	Ground	
	Input	Natural resource	Zinc	1100			mg	Ground	
	Output	Emission	As	130			mg	Air	
	Output	Emission	BOD	620			mg	Water	
	Output	Emission	Calcium	420			mg	Water	
	Output	Emission	CH4	1700			mg	Air	
	Output	Emission	Cl	290000			mg	Water	
	Output	Emission	CO	6000			mg	Air	
	Output	Emission	CO2	3700000			mg	Air	
	Output	Emission	COD	1400			mg	Water	
	Output	Emission	Cu	11			mg	Water	
	Output	Emission	Cu	480			mg	Air	
	Output	Emission	Dissolved solids	670000			mg	Water	
	Output	Emission	HC	35000			mg	Air	
	Output	Emission	HCl	470			mg	Air	
	Output	Emission	HF	23			mg	Air	
	Output	Emission	NH4	28			mg	Water	
	Output	Emission	NO3-N	170			mg	Water	
	Output	Emission	NOx	32000			mg	Air	
	Output	Emission	Pb	3000			mg	Air	
	Output	Emission	SO4	120000			mg	Water	
	Output	Emission	SOx	700000			mg	Air	
	Output	Emission	Sulphur	1100			mg	Water	
	Output	Emission	Susp solids	30000			mg	Water	
	Output	Emission	Zn	380			mg	Air	
	Output	Product	Blister copper	1			kg	Technosphere	
	Output	Residue	Ashes	93000			mg	Technosphere	

	Output	Residue	Hazardous waste	7			mg	Technosphere	
	Output	Residue	Industrial waste	4500			mg	Technosphere	
	Output	Residue	Mineral waste	100000000			mg	Technosphere	

About Inventory	
Publication	Ecoprofile of Primary Copper Production- A report for The International Copper Association By Dr. I. Boustead. 1998. -- Data documented by: Sofia Medin, Electrolux ESD Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose of this work was to produce life-cycle inventory data for the production of primary copper and the sub-processes based on data submitted by members of the International Copper Association from their own operations.
Detailed Purpose	The aim is to provide ''cradle to gate'' data for the production of blister copper, which is a sub-process in the production of primary copper
Commissioner	- The International Copper Association .
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	There is no recommendation of how to use the data from this report. This activity is part of a ''cradle to gate'' system for primary copper production. In the sequence of operations leading up to primary copper production there are six main stages involved. These are 1) Copper ore mining; 2) Copper ore concentrate preparation and delivery; 3) Production of matte copper; 4) Production of blister copper; 5) Production of copper anodes and 6) Production of primary copper. This activity only covers the stages 1) copper ore mining, 2) copper ore concentrate preparation and delivery, 3) Production of matte copper and 4) Production of blister copper. All six stages in the primary copper production have been described cumulatively in separate activities in the database.
About Data	The data used for electricity and fuel production in the calculations leading to the results reported comes from the reports of International Energy Agency. Data Assumtions: Data received from participating companies show sometime wide variation with respect to metal contents of ore and various intermediate products such as concentrates, gas dust and scrap. Therefor has the following assumptions been made: 1. Copper content in ore. Where actual data on copper content of the ore were available these were used. Otherwise the content was calculated on the basis of mass flow. 2. Copper content of matte according to published literature is between 40% to 75%. The assumption made, where the copper content in matte was not derived from mass flow, is therefor 60 %. 3.Average copper content of blister was assumed to be 98,5%, based on published litterature. 4. There is also some loss of copper during ore preperation and the smelting and recovery processes. The loss can be calculated from the mass flow if accurate contents of the input and output materials where known.Where this is not possible, the loss is assumed to be 1% at each step of the sequence of operations. It is further assumed that there is another 4% loss of copper during the operational steps from ore preperation to electro-refining, making the total loss of copper to 5%.
Notes	The results of the Ecoprofile study has been broken down into a number of categories, identifying the type of operation that gives rise to them. The categories are: 1. Fuel production 2. Fuel use 3. Process 4. Transport 5. Biomass (inputs and outputs associated with the use of biological materials such as wood)

SPINE LCI dataset: Production of brass cages used for spherical roller bearings

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Production of brass cages used for spherical roller bearings
Functional Unit	One brass cage, 55,6 kg
Functional Unit Explanation	One spherical roller bearing 232/530 consists of following components: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 rollers (coated or non-coated) The functional unit for this process is one brass cage. The data can finally be used (together with data for the other ingoing components) to calculate environmental impact for a complete spherical roller bearing 232/530 Dimensions of the bearing: di= 530 mm dy= 980 mm breadth= 355 mm The activities for the production of the other ingoing components are also available at SPINE@CPM: * Production of bearing rings * Production of bearing rollers (á 9.2 kg) * Production of guide rings used for spherical roller bearings and the activity for the production of a complete SRB 232/530 can be found as: * Production of SKF Spherical Roller Bearing 232/530
Process Type	Gate to gate
Site	SKF Sverige AB415 50 GÖTEBORG
Sector	Materials and components
Owner	SKF Sverige AB415 50 GÖTEBORG
Technical system description	Production of one brass cage CS 232/530 CAM, 55,6 kg. This cage is to be mounted into the SKF spherical roller bearing 232/530. The brass cage has the function of keeping the rollers separated in the bearing. The cage is made at SKFs site in Göteborg. The raw material is brass cylinders supplied by BecoTek AS in Norway. The brass for their production in Norway is bought from Olof Manners AB in Mölndal, Sweden. The production of brass is not included in this dataset, but must be followed from the cradle for a total environmental impact. The transport of brass from Mölndal in Sweden to Åmot in Norway is NOT included in the dataset. The following process steps are included in this dataset: (1 and 2 are described in separate activities in the SPINE@CPM database) 1. Production of turned brass cylinders, 205 kg. 2. Manufacturing of brass cages at SKFs site in Göteborg. 3. Transport of brass scrap from SKF in Göteborg to Västerås (where the brass is recycled at Nordic Brass AB). The mineral oil in the cutting fluid used at SKFs site in Göteborg is followed from the cradle with the activities: 4. Extraction of crude oil 5. Refining of crude oil And to the grave with the activity: 6. Combustion of waste oil Also the transport is considered: 7. Transport of cutting fluid emulsion from Göteborg to Halmstad where the cutting fluid emulsion is burnt. Diesel production and electricity production (Swedish average for manufacturing of brass

	cages at SKFs site in Göteborg, and European average for the production of turned brass cylinders) ARE included for the activities. --- First the brass is smelted in electric furnaces at the plant in Åmot, Norway. The smelt is then poured into a form and casted into desired shape. The cylinders formed are then turned in a turning machine and finally inspected and packed. All scrap produced in the process is recycled and used in the smelting process as raw material. The energy consumption was reported from BecoTek (= 1.19 kWh/kg). Also internal transport by electric truck (40 m for each cylinder) and diesel truck (40 m for each cylinder) were reported. The environmental impact is probably significantly higher since no other inflows or outflows from the process are measured. The brass cylinders are transported to SKF in Göteborg by truck. (weight of the turned brass cylinder is 205 kg) (this transport is NOT included in the dataset) At the SKF plant in Göteborg the brass cylinders are treated and processed in several steps to obtain the desired shape. 1. First the cylinders are turned in the Morando lathe. 2. The cylinders are then drilled. The drilling takes about 93 minutes and is the most time consuming step in the process. 3. To get rid of sharp edges from the drilling, the cages are then ground by hand. 4. The last step is to trumble the cages with trumble chips made of ceramic stones to get a smooth surface. The cages are then transported, by industrial trucks, to the C-factory at SKF where the final assembly into the SKF Spherical Roller Bearing 232/530 takes place. (1 km electric truck transport is included) The trumbling chips are NOT included in this study, since the amount of chips needed for one cage was insignificant. Also the energy consumption for the trumbling of the cages was neglected since it is very small in comparison to the energy consumption of the other process equipment. The brass-scrap from the SKF process is transported to Västerås, Sweden, for complete recycling. The cutting fluid is transported to Halmstad for destruction and use as energy source in the Cement-industry.

System Boundaries	
Nature Boundary	The production of brass is not included in this study, so the inflow of brass is coming from the technosphere. This MUST be accounted for when using this dataset. (Data from brassproduction is available e.g. from CIT Ekologik AB, Chalmers) Emissions to water and air are not known for the production of turned brass cylinders in Norway. Only energy consumption (1,19 kWh/kg brass) and internal transport (40 m electric truck and 40 m diesel truck) are included from that process . From SKF no emissions to air are included since they were not known and measured. The trumble chips are not followed from the cradle and not to the grave. The brass scrap that leaves the system is considered to be a co-product since it is used as raw material for new products and thus the boundary is the technosphere. The mineral oil in the cutting fluid has been accounted for. The cutting fluid is an emulsion with water and 4% of CASTROL SW 3420. According to the product data sheet for CASTROL SW 3420 it contains of 40% mineral oil. Databases for ''Extraction of crude oil'' and ''Refining of crude oil'' from SPINE@CPM have been used for tracing the mineral oil to its cradle. The activity ''Combustion of waste oil'' has been used for following the mineral oil to its grave. This is also a separate activity that can be found in SPINE@CPM database. When calculating the transport of cutting fluid from Göteborg to Halmstad the cutting fluid is not yet separated. This means that the weight of water is also included in ''cargo''.
Time Boundary	The data is collected during autumn 2002. No changes in the procedure are planned for the nearest future.
Geographical Boundary	The brass cylinders are produced in Åmot, Norway. The manufacturing of cages takes place at SKF in Göteborg, Sweden. The final disposal of brass and waste oil takes place in Sweden (Västerås and Halmstad).
Other Boundaries	The transports from Göteborg to Halmstad (cutting fluid emulsion) and from Göteborg to Västerås (brass scrap) are included with diesel production. In the activity ''Manufacturing of brass cages at SKFs site in Göteborg'' also internal transport within SKF industrial area 1 km electric truck is included and the electricity production needed for this (0,75 kWh/km). Internal transport (40 m electric truck and 40 m diesel truck) are included for the production of turned brass cylinders in Norway. Assumptions were made at BeTe Trucks AB in Sweden how much energy a dieseltruck and an electric truck consume per km (=0,75 KWh/km (el) and 0,3 litre/km (diesel)). The heating value for diesel (=35, 31 MJ/litre) was found at Internet: www.fast-tech.com and the diesel consumption could be calculated to 0,42372 MJ/40m. The diesel production is included in the dataset. All electricity production is included. Average European electricity is used for the activity '' Production of turned brass cylinders'' at BecoTek in Norway and Swedish average electricity is used for the activity ''Manufacturing of brass cages at SKFs site in Göteborg''. The refining of crude oil is assumed to take place in Sweden and thus Swedish average electricity production is used for this activity.

Allocations	Allocations have been made according to weight for the Production of turned brass cylinders in Norway. For the process at SKF in Göteborg the data is production specific to the specific cage. The time in the different process equipment can vary for different cages of different dimensions, and thus also energy consumption varies. The cutting fluid used in the process is allocated according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	
Method	The data from the manufacturing of cages at SKF has been collected during a visit at the specific production site and from interviews with the production manager Christer Landgren. Much of the data is monitored e.g the consumption of cutting fluid, and the processing time for the cages in the diffferent process equipment. The brass cage is weighted before and after, to understand how much scrap is produced. For the production of brass cylinders in Norway at Beco Tek, the energy consumption is estimated by Eirik Hjerpaasen. Data for the production of brass is taken from a CIT database. For more specific information see under the sub activities: ''Production of turned brass cylinders'' and ''Manufacturing of brass cages at SKFs site in Göteborg''.
Literature Reference	
Notes	

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Aluminium	4.821e-005			kg	Technosphere	
	Input	Refined resource	Brass	205			kg	Technosphere	
	Input	Refined resource	Crude oil	0.0276			MJ	Technosphere	
	Input	Refined resource	Iron	5.005e-005			kg	Technosphere	
	Input	Refined resource	Lime	0.001524			kg	Technosphere	
	Input	Refined resource	Manganese	2.801e-007			kg	Technosphere	
	Input	Refined resource	Municipal water	0.8256			kg	Technosphere	
	Input	Refined resource	Oxygen	0.01783			kg	Technosphere	
	Input	Refined resource	Sulphuric acid	0.002551			kg	Technosphere	
	Input	Refined resource	Thermal energy	0.01093			MJ	Technosphere	
	Input	Resource	Bentonite	0.000158			kg	Ground	
	Input	Resource	Biomass	0.2934			kg	Ground	
	Input	Resource	Chalk	8.448e-005			kg	Ground	
	Input	Resource	Clay	1.809e-005			kg	Ground	
	Input	Resource	Copper in ore	0.000228			kg	Ground	
	Input	Resource	Crude oil	8.147			kg	Ground	
	Input	Resource	Crude oil, feedstock	4.013e-006			kg	Ground	
	Input	Resource	Ground water	1.071e-006			kg	Ground	
	Input	Resource	Hard coal	39.54			kg	Ground	
	Input	Resource	Hydro power	178.7			MJ	Ground	
	Input	Resource	Iron in ore	0.001125			kg	Ground	
	Input	Resource	Lead in ore	4.052e-006			kg	Ground	
	Input	Resource	Lignite	31.45			kg	Ground	
	Input	Resource	Natural gas	4.986			kg	Ground	
	Input	Resource	Sodium chloride	8.439e-005			kg	Ground	
	Input	Resource	Softwood	0.01976			kg	Ground	

	Input	Resource	Surface water	2.187e-008			kg	Ground	
	Input	Resource	Unspecified fuel	0.0004742			MJ	Ground	
	Input	Resource	Uranium in ore	0.003296			kg	Ground	
	Input	Resource	Wind power	0.1185			MJ	Ground	
	Input	Resource	Wood	0.0008352			kg	Ground	
	Output	Co-product	Brass	149.4			kg	Technosphere	
	Output	Co-product	Gasoline	1.507			MJ	Technosphere	
	Output	Emission	Acid as H+	1.809e-005			kg	Water	
	Output	Emission	Al	5.026e-005			kg	Water	
	Output	Emission	Aldehydes	7.447e-007			kg	Air	
	Output	Emission	Aromates (C9-C10)	1.993e-005			kg	Air	
	Output	Emission	Aromates (C9-C10)	6.226e-006			kg	Water	
	Output	Emission	Aromatics	3.316e-009			kg	Water	
	Output	Emission	As	4.116e-006			kg	Air	
	Output	Emission	As	8.008e-007			kg	Water	
	Output	Emission	B	0.001203			kg	Air	
	Output	Emission	Benzene	0.0001704			kg	Air	
	Output	Emission	Benzo(a)pyrene	7.192e-009			kg	Air	
	Output	Emission	BOD	3.012e-006			kg	Water	
	Output	Emission	BOD5	3.862e-006			kg	Water	
	Output	Emission	BOD-7	8.789e-008			kg	Water	
	Output	Emission	Cd	2.128e-006			kg	Air	
	Output	Emission	Cd	3.943e-007			kg	Water	
	Output	Emission	Cl-	0.5596			kg	Water	
	Output	Emission	CN-	1.713e-006			kg	Air	
	Output	Emission	CN-	2.047e-007			kg	Water	
	Output	Emission	CO	0.09598			kg	Air	
	Output	Emission	Co	2.977e-006			kg	Air	
	Output	Emission	Co	5.216e-008			kg	Water	
	Output	Emission	CO2	120.3			kg	Air	
	Output	Emission	COD	0.0001338			kg	Water	
	Output	Emission	Cr	3.669e-008			kg	Air	
	Output	Emission	Cr	6.437e-007			kg	Water	
	Output	Emission	Cr3+	5.172e-006			kg	Water	
	Output	Emission	Cr3+	7.025e-006			kg	Air	
	Output	Emission	Cu	1.827e-005			kg	Air	
	Output	Emission	Cu	2.116e-007			kg	Water	
	Output	Emission	Cyanide	1.665e-010			kg	Water	
	Output	Emission	Dioxin	3.319e-011			kg	Air	
	Output	Emission	Dissolved organic carbon	1.554e-013			kg	Water	
	Output	Emission	Dissolved solids	0.02378			kg	Water	
	Output	Emission	F-	0.0001432			kg	Water	
	Output	Emission	Fe	0.04909			kg	Water	
	Output	Emission	H2S	1.434e-006			kg	Air	
	Output	Emission	H2S	6.701e-009			kg	Water	
	Output	Emission	HC	4.878e-006			kg	Air	
	Output	Emission	HCl	0.006296			kg	Air	
	Output	Emission	Heavy metals	2.898e-018			kg	Air	
	Output	Emission	HF	0.000108			kg	Air	
	Output	Emission	Hg	3.323e-013			kg	Water	
	Output	Emission	Hg	6.616e-006			kg	Air	
	Output	Emission	Hydrocarbons	0.001105			kg	Air	
	Output	Emission	Hydrocarbons	2.187e-005			kg	Water	
	Output	Emission	Metals	3.012e-006			kg	Water	
	Output	Emission	Metals	6.024e-007			kg	Air	
	Output	Emission	Methane	0.3373			kg	Air	
	Output	Emission	Mg	0.0003548			kg	Air	
	Output	Emission	Mn	1.221e-005			kg	Air	
	Output	Emission	Mn	6.086e-006			kg	Water	
	Output	Emission	Mo	1.668e-006			kg	Air	
	Output	Emission	N total	0.0008451			kg	Water	
	Output	Emission	N2O	0.00432			kg	Air	
	Output	Emission	NH3	5.366e-006			kg	Air	
	Output	Emission	NH3	7.675e-009			kg	Water	

		Output	Emission	NH4+ as N	0.0003434			kg	Water	
		Output	Emission	Ni	0.0001015			kg	Air	
		Output	Emission	Ni	4.757e-006			kg	Water	
		Output	Emission	Nitrogen	1.344e-005			kg	Water	
		Output	Emission	NMVOC	0.009219			kg	Air	
		Output	Emission	NMVOC, diesel engines	0.001809			kg	Air	
		Output	Emission	NMVOC, natural gas combustion	0.0003794			kg	Air	
		Output	Emission	NMVOC, oil combustion	0.05137			kg	Air	
		Output	Emission	NMVOC, petrol engines	2.222e-013			kg	Air	
		Output	Emission	NMVOC, power plants	0.00101			kg	Air	
		Output	Emission	NO3- as N	1.827e-007			kg	Water	
		Output	Emission	NOx	0.3565			kg	Air	
		Output	Emission	N-tot	1.13e-007			kg	Water	
		Output	Emission	Oil	0.00674			kg	Water	
		Output	Emission	Other organics	0.005092			kg	Water	
		Output	Emission	Other organics	1.493e-006			kg	Air	
		Output	Emission	P total	8e-006			kg	Water	
		Output	Emission	PAH	1.504e-009			kg	Air	
		Output	Emission	Particles	0.0656			kg	Air	
		Output	Emission	Particulates	2.298e-007			kg	Air	
		Output	Emission	Pb	1.531e-005			kg	Air	
		Output	Emission	Pb	2.936e-006			kg	Water	
		Output	Emission	Phenol	3.316e-010			kg	Water	
		Output	Emission	PO43-	1.934e-005			kg	Water	
		Output	Emission	P-tot	1.83e-009			kg	Water	
	Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	3.369e+008			Bq	Air	
	Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	8.911e+005			Bq	Water	
	Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Rn-222	1.58e+006			Bq	Air	
		Output	Emission	Sb	1.528e-006			kg	Air	
		Output	Emission	Sb	7.328e-010			kg	Water	
		Output	Emission	Se	1.827e-005			kg	Air	
		Output	Emission	Sn	2.749e-007			kg	Air	
		Output	Emission	Sn	5.744e-005			kg	Water	
		Output	Emission	SO2	0.9266			kg	Air	
		Output	Emission	SO42-	0.3285			kg	Water	
		Output	Emission	Sodium chloride	0.1098			kg	Water	
		Output	Emission	Sr	0.0001177			kg	Water	
		Output	Emission	Sr	1.238e-005			kg	Air	
		Output	Emission	Susp solids	9.951e-008			kg	Water	
		Output	Emission	Suspended solids	0.0003881			kg	Water	
		Output	Emission	Th	1.967e-007			kg	Air	
		Output	Emission	Tl	3.39e-008			kg	Air	
		Output	Emission	U	1.888e-007			kg	Air	
		Output	Emission	V	0.0003117			kg	Air	
		Output	Emission	V	1.719e-007			kg	Water	
		Output	Emission	VOC	0.00404			kg	Air	
		Output	Emission	VOC, coal combustion	2.977e-005			kg	Air	
		Output	Emission	VOC, diesel engines	0.0008228			kg	Air	
		Output	Emission	VOC, natural gas combustion	2.318e-012			kg	Air	
		Output	Emission	Zn	0.0001096			kg	Water	

	Output	Emission	Zn	3.24e-005			kg	Air	
	Output	Product	Brass cage	55.6			kg	Technosphere	
	Output	Residue	Bulky	12.38			kg	Technosphere	
	Output	Residue	Chemicals	9.484e-005			kg	Technosphere	
	Output	Residue	Demolition	0.001065			kg	Technosphere	
	Output	Residue	Hazardous	2.363			kg	Technosphere	
	Output	Residue	Highly radioactive	0.0006981			kg	Technosphere	
	Output	Residue	Industrial	13.45			kg	Technosphere	
	Output	Residue	Mineral	0.001229			kg	Technosphere	
	Output	Residue	Other	1.683			kg	Technosphere	
	Output	Residue	Radioactive	0.008492			kg	Technosphere	
	Output	Residue	Rubber	1.44e-005			kg	Technosphere	
	Output	Residue	Slags & ashes	0.06683			kg	Technosphere	
	Output	Residue	Slags & ashes (energy production)	2.854			kg	Technosphere	
	Output	Residue	Slags & ashes (waste incineration)	1.844e-007			kg	Technosphere	
	Output	Residue	Sludge	0.003214			kg	Technosphere	
	Output	Residue	Water	0.8256			kg	Water	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for production of brass cages of this dimension at the specific site at SKF in Göteborg, Sweden. Note that the transportation of cutting fluid (Gbg-Halmstad) and brass scrap (Gbg-Västerås) must be the same since these transports are included in the dataset. The data can be used (together with data for the other ingoing components) to calculate environmental impact for a complete SKF spherical roller bearing 232/530. The activities for the production of the other ingoing components are also available at SPINE@CPM: * Production of bearing rings * Production of bearing rollers (á 9.2 kg) * Production of guide rings used for spherical roller bearings and the activity for the production of a complete SRB 232/530 can be found as: * Production of SKF Spherical Roller Bearing 232/530
About Data	Data is gathered from interviews with Eirik Hjerpaasen at BecoTek AS, Norway and Christer Landgren at SKF Sverige AB.
Notes	

SPINE LCI dataset: Production of butadiene

Administrative	
Finished	Y
Date Completed	1999-01-01
Copyright	APME
Availability	Public

Technical System	
Name	Production of butadiene
Functional Unit	1 kg butadiene
Functional Unit Explanation	Butadiene is a C4-hydrocarbon with two double bonds, which makes it very reactive. Butadiene is mainly used for producing PB, ABS, SB-rubber, nitrile rubber and chloroprene. Butadiene is a product mainly from steam cracking of naphta.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Production of butadiene include all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. A significant part of the butadiene used in Europe is derived directly from the steam cracking of natural gas or the naphta fraction of crude oil. Cracking is a three-stage process wich includes the steps: furnace, quench (for cooling) and separation (fractional distillation). In addition to butene isomers, the process also produces ethylene, propylene and a number of other hydrocarbons. Some of these will be extracted and some will be fed back to the furnace. An alternative source of butadiene is the dehydrogenation of the mixed butene fraction from steam cracking. The butenes are first purified to remove any non-C4 hydrocarbons and the iso-butene is removed with sulphuric acid. The mixture of 1- and 2-butene are mixed with steam and heated when the conversion to butadiene rapidly occurs in the presence of an iron oxide or calcium nickel phosphate catalyst. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and deliver; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been tracked back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 4 plants in 3 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. For raw materials, inputs as listed from APME, have been reocorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries	
Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values.

	Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1989-1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data supplied by 4 butadiene production plants in 3 countries: Italy, Netherlands and UK. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Data were supplied from 4 butadiene production plants in UK, Netherlands and Italy. Their total production was 452,000 tonnes. .
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1989-1995
Data Type	Derived, mixed
Represents	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been

	translated into the nomenclature by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New name: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.
Method	European average data. Results are based on data supplied by 4 butadiene production plants in 3 countries: UK, Netherlands and Italy. Their total production was 452,000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied whereever there have been sufficient data from upstream raw material and fuel producers. In verticall averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the caluclations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emissions. For fuels and feedstock materials, actual gross calorific values (energy conten) have been used in teh calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports /htm/alphabetical.htm
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	87469.91339			mg	Air	Europe
	Input	Natural resource	Barytes	0.290806358			mg	Ground	Europe
	Input	Natural resource	Bauxite	427.2764698			mg	Ground	Europe
	Input	Natural resource	Bentonite	142.2567611			mg	Ground	Europe
	Input	Natural resource	Biomass	349.2520876			mg	Ground	Europe
	Input	Natural resource	Calcium fluoride	3.67E-02			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	14.19013804			mg	Ground	Europe
	Input	Natural resource	Chalk	5.43E-21			mg	Ground	Europe
	Input	Natural resource	Chromium in ore	6.90E-04			mg	Ground	Europe
	Input	Natural resource	Clay	18.63235082			mg	Ground	Europe
	Input	Natural resource	Crude oil	1145377.994			mg	Ground	Europe
	Input	Natural resource	Dolomite	6.021060782			mg	Ground	Europe
	Input	Natural resource	Feldspar	9.43E-27			mg	Ground	Europe
	Input	Natural resource	Ferromanganese in ore	0.434889604			mg	Ground	Europe
	Input	Natural resource	Granite	2.02E-04			mg	Ground	Europe
	Input	Natural resource	Gravel	1.76656638			mg	Ground	Europe
	Input	Natural resource	Hard coal	47388.46721			mg	Ground	Europe
	Input	Natural resource	Hydro energy	3.12E-02			MJ	Ground	Europe
	Input	Natural resource	Iron in ore	569.7462757			mg	Ground	Europe
	Input	Natural resource	Lead in ore	0.157914915			mg	Ground	Europe
	Input	Natural resource	Lignite	5075.855304			mg	Ground	Europe
	Input	Natural resource	Limestone	638.0945053			mg	Ground	Europe
	Input	Natural resource	Magnesium	0			mg	Ground	Europe
	Input	Natural resource	Natural gas	593553.5693			mg	Ground	Europe
	Input	Natural resource	Nickel in ore	1.55E-04			mg	Ground	Europe
	Input	Natural resource	Nitrogen	1414169.787			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	0.482921258			MJ	Ground	Europe
	Input	Natural resource	Olivine	4.491940697			mg	Ground	Europe
	Input	Natural resource	Oxygen	17.05225782			mg	Ground	Europe
	Input	Natural resource	Peat	0.811411452			mg	Ground	Europe
	Input	Natural resource	Phosphate	5.63E-03			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	20.1864453			mg	Ground	Europe
	Input	Natural resource	Rutile	7.80E-21			mg	Ground	Europe
	Input	Natural resource	Sand	40.39206835			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	1271.272839			mg	Ground	Europe
	Input	Natural resource	Sulphur	53.63667742			mg	Ground	Europe
	Input	Natural resource	Sulphur in ore	165.9136615			mg	Ground	Europe
	Input	Natural resource	Talc	0			mg	Ground	Europe
	Input	Natural resource	Water	60187754.24			mg	Water	Europe

		Input	Natural resource	Wood	2.133615044			mg	Ground	Europe
		Input	Natural resource	Zinc in ore	5.94E-03			mg	Ground	Europe
		Output	By-product	Recovered energy	1.512098307			MJ	Technosphere	Europe
		Output	Emission	1,2-Dichloroethane	6.65E-12			mg	Water	Europe
		Output	Emission	1,2-Dichloroethane	9.28E-08			mg	Air	Europe
		Output	Emission	Acid as H+	34.0427566			mg	Water	Europe
		Output	Emission	Al3+	1.884394908			mg	Water	Europe
		Output	Emission	Aldehydes	1.62E-04			mg	Air	Europe
		Output	Emission	As	1.10E-03			mg	Water	Europe
		Output	Emission	BOD	15.30860467			mg	Water	Europe
		Output	Emission	Ca2+	0.122810336			mg	Water	Europe
		Output	Emission	CFCs	3.48E-02			mg	Air	Europe
		Output	Emission	Chloroorganics	4.26E-03			mg	Water	Europe
		Output	Emission	Chloroorganics	7.85E-03			mg	Air	Europe
		Output	Emission	Cl-	100.1835043			mg	Water	Europe
		Output	Emission	Cl2	2.02E-04			mg	Air	Europe
		Output	Emission	Cl2	5.17E-03			mg	Water	Europe
		Output	Emission	CN-	2.10E-03			mg	Water	Europe
		Output	Emission	CO	1960.310788			mg	Air	Europe
		Output	Emission	CO2	1559131.914			mg	Air	Europe
		Output	Emission	CO32-	151.6037107			mg	Water	Europe
		Output	Emission	COD	102.988993			mg	Water	Europe
		Output	Emission	CrO3	8.30E-04			mg	Water	Europe
		Output	Emission	CS2	6.82E-04			mg	Air	Europe
		Output	Emission	Cu	2.47E-02			mg	Water	Europe
		Output	Emission	Dissolved organics	37.916263			mg	Water	Europe
		Output	Emission	Dissolved solids	192.9809843			mg	Water	Europe
		Output	Emission	Dust	1157.067991			mg	Air	Europe
		Output	Emission	F-	1.69E-03			mg	Water	Europe
		Output	Emission	F2	4.08E-05			mg	Air	Europe
		Output	Emission	Fe	2.32E-02			mg	Water	Europe
		Output	Emission	H2	4.134693338			mg	Air	Europe
		Output	Emission	H2S	1.67E-02			mg	Air	Europe
		Output	Emission	H2SO4	5.36E-08			mg	Air	Europe
		Output	Emission	HCl	25.39003994			mg	Air	Europe
		Output	Emission	HCN	2.67E-26			mg	Air	Europe
		Output	Emission	HF	1.299733047			mg	Air	Europe
		Output	Emission	Hg	7.81E-05			mg	Water	Europe
		Output	Emission	Hg	9.36E-04			mg	Air	Europe
		Output	Emission	K+	0.594905839			mg	Water	Europe
		Output	Emission	Metals	2.015798215			mg	Air	Europe
		Output	Emission	Metals	8.250652417			mg	Water	Europe
		Output	Emission	Methane	6164.841703			mg	Air	Europe
		Output	Emission	Mg2+	4.95E-03			mg	Water	Europe
		Output	Emission	N total	2.90908733			mg	Water	Europe
		Output	Emission	N2O	0.24878279			mg	Air	Europe
		Output	Emission	Na+	224.4606317			mg	Water	Europe
		Output	Emission	NH3	8.47E-04			mg	Air	Europe
		Output	Emission	NH4+	2.00662428			mg	Water	Europe
		Output	Emission	Ni	1.15E-03			mg	Water	Europe
		Output	Emission	NO3-	5.792355704			mg	Water	Europe
		Output	Emission	NOx	7006.237959			mg	Air	Europe
		Output	Emission	Oil	236.7628831			mg	Water	Europe
		Output	Emission	Other organics	11.8197193			mg	Water	Europe
		Output	Emission	P2O5	7.48E-02			mg	Water	Europe
		Output	Emission	PAH	4.36E-27			mg	Air	Europe
		Output	Emission	Pb	1.56E-04			mg	Air	Europe
		Output	Emission	Pb	5.39E-04			mg	Water	Europe
		Output	Emission	Phenol	2.16860575			mg	Water	Europe
		Output	Emission	S2-	4.34E-04			mg	Water	Europe
		Output	Emission	SO2	6045.838624			mg	Air	Europe
		Output	Emission	SO42-	344.2545327			mg	Water	Europe
		Output	Emission	Suspended solids	447.3194679			mg	Water	Europe
		Output	Emission	Thiols	0.201717544			mg	Air	Europe
		Output	Emission	Vinyl chloride	1.02E-23			mg	Water	Europe

	Output	Emission	Vinyl chloride	1.40E-09			mg	Air	Europe
	Output	Emission	VOC	1585.218013			mg	Air	Europe
	Output	Emission	VOC	67.69085578			mg	Water	Europe
	Output	Emission	Zn2+	1.57E-02			mg	Water	Europe
	Output	Residue	Construction	1.28E-02			mg	Ground	Europe
	Output	Residue	Industrial	640.7267754			mg	Ground	Europe
	Output	Residue	Inert chemicals	258.1357924			mg	Ground	Europe
	Output	Residue	Metals	8.03778232			mg	Ground	Europe
	Output	Residue	Mineral	11514.60113			mg	Ground	Europe
	Output	Residue	Paper	0.00E+00			mg	Ground	Europe
	Output	Residue	Plastics	0.417718143			mg	Ground	Europe
	Output	Residue	Regulated chemicals	348.8072744			mg	Ground	Europe
	Output	Residue	Slags & ashes	3089.711263			mg	Ground	Europe
	Output	Residue	To incinerator	109.0120082			mg	Technosphere	Europe
	Output	Residue	To recycling	181.8782544			mg	Technosphere	Europe
	Output	Residue	Unspecified	44.68864536			mg	Ground	Europe
	Output	Residue	Wood waste	2.12E-02			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for Butadiene. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME´s web site http://lca.apme.org. -- Documented by: Sofia Boström, Volvo Technological Development Corporation Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 24 May 2002 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to butadiene.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes 2. Provide valuable inventory data for downstream users of butadiene, for instance plastic manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: -Plastic waste management stidues - Internal company benchmarking - Product development. Detailed environmental information to customers of APME memebers for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-1993, the period to which the oldest group of Eco-profiles data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - .
Practitioner	Ian Boustedt - .
Reviewer	
Applicability	European average data. Data were supplied from 4 butadiene producers in UK, Netherlands and Italy. Their total production was 432,000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison

	between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for butadiene production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of butadiene in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols

	Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

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SPINE LCI dataset: Production of cameras, magazines and accessories

Administrative	
Finished	Y
Date Completed	1996-03-01
Copyright	
Availability	Public

Technical System	
Name	Production of cameras, magazines and accessories
Functional Unit	camera and 1,77 magazines
Functional Unit Explanation	The environmental load per produced camera and 1,77 magazines. There is also a production of accessoires that is not included in the functional unit. This is not a good functional unit because the basic components, such as metal plates etc, used in the production are not included. The optics are bought and not included.
Process Type	Gate to gate
Site	Victor Hasselblad AB Box 220 401 23 Göteborg Sweden
Sector	Consumer goods
Owner	Victor Hasselblad AB Box 220 401 23 Göteborg Sweden
Technical system description	Victor Hasselblad AB produces cameras, magazines and accessories. The main process consists of surface treatment of the material used in the cameras. The processes are chromium-plating, eloxering, nickel-plating, cadmium-plating, gold-plating, tumbling, degreasing and painting. The plates are shaped in the mechanical work shop. DETALIED DESCRIPTION The materials used for the components to the camera are aluminium, brass, steel, stainless steel and a small amount of magnesium. In the mechanical work-shop the components are shaped. SURFACE TREATMENT The surface treatment is the part of the productrion that is the most hazardous to the environment. All rinsing water and other leakage that may occur in the processes is led to the internal purification plant. The processes used are the following: Chromium-plating, eloxering, nickel-plating, cadmium-plating, gold-plating, tumbling, degreasing and painting. Chromium-plating: The goods that are plated with chromium is made of aluminium, brass or steel. The tubs

	contain 1-1,5 m3. The rinsing water is controlled manually, with a rotameter, exept for the rinse after the chrome, where a conductivity meter has been installed. Anodizing: The goods treated are made of aluminium and stainless steel. The black coloured bath is recirculated continiously through a filter. The rinsing water is controlled manually, with a rotameter, exept for the postpackning bath, where a conductivity meter has been installed. Nickel-plating: All the tubs contain 0,7 m3. Only aluminium is trated. The nickel and the copper baths are recirculated continiously through a filter. The rinsing water from the nickel-plating is secluded, so that no water is let out. The rinsing water is controlled manually, with a rotameter. Cadmium-plating: All the tubs contain 0,7 m3. Magnesium, brass and steel goods are plated. The rinsing water is controlled manually, with a rotameter. Gold-plating: Aluminium, brass, steel and stainless steel goods are plated with gold. The rinsing water is controlled manually, with a rotameter. The nickel bath is recirculated continiously through a filter. Trumbling: The goods that are trumbled consist of detaljs of aluminium (65%), brass (20%), steel (10%) and magnesium (5%). The rinsing water consist of fresh water from the municipal. Cooling water is kept in a cooling tank and used as rinse water. Degreasing: Degreasing with organic solvents is done in one machine, and alcaline degreasing in two machines. Rejected water is led to the internal purification plant. In the mecanical woorkshops there is a tricleaner, which is used occasionally. The cleaner has no recycling equipment. (The cleanber is planed to be taken out of production during 1995.) Painting: There are five spray boothes with water curtains at the department of lacquering. The system is secluded, and empied by RECI. There is also a convection kiln used to fire lacquered goods, and a belt furnace used to IR-fire lacquered goods. The finished components are assembled into cameras, magazines and accessories.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	Only the painting and surface treatment departments are accounted for in the environmental report.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified

Represents	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New name: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.
Method	Study the environmental report The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1995. The total production during 1995 is 13 000 cameras, 23 000 magazines and accessoires.
Literature Reference	Environmental report for Victor Hasselblad AB from 1996, The Environmental Administration in the municipality of Göteborg, Sweden Some information has been gathered through personal communication with Stig Wilén, Victor Hasselblad AB.
Notes	The average pH during 1995 was 8,5 and the average flow of waste water is 50 m3/day.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Acetic acid	0.0154			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Alstan 71	0.0077			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Consist of Calium hydrixide 10-20% and Sodium salt complex 30-60%. Used for surface treatment	Input	Refined resource	Alstan 72	0.000385			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Set Calium 40-60% and Sodium gluconate 5-15%. Used for surface treatment	Input	Refined resource	Alstan 75	0.0673			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Ammonia	0.00354			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Ammonium bifluorid	0.0115			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Ansatzlösung	0.00577			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Boric acid	0.0077			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Boric fluorine acid	0.0115			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for painting. Rest products from the substance is taken care of by Stena Miljö.	Input	Refined resource	Boxkemikalie T225	0.0077			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Cadmium cyanide	0.00131			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Chromium trioxide	0.0523			kg	Technosphere	
Date concieved: 1995 Data type: Economical information	Input	Refined resource	Citric acid	0.0077			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Ajax allrengöring (32%) and Rent Extra (68%).	Input	Refined resource	Cleaners	0.0588			l	Technosphere	
Date concieved: 1995 Data type: Estimated from similarity Notes: Used for painting.	Input	Refined resource	Controx 249 DV	0			g	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Copper cyanide	0.00192			kg	Technosphere	

Date concieved: 1995 Data type: Economical information Notes: A photo chemical. Rest products from the substance is taken care of by Stena Miljö.	Input	Refined resource	D 76 Developer	0.0162			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: 59,7% Cleaner 35 and 40,3% Alstan 10 (Sodium carbonate 20-50%, Trisodium phosphate 20-50% and Sodium gluconate 5-20%)	Input	Refined resource	Degreasing agents	0.0458			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Sumazon FL (64,7%) is used as dishwasher detergent, Ajax (35,3%) used as a detergent.	Input	Refined resource	Detergents	0.0131			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Econochrom BK	0.000769			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Electricity and district heating. Includes both heating and production. Originally stated as MW (not MWh).	Input	Refined resource	Energy (non-material)	0.000292			MWh	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Galtin 140	0.0308			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Glanzzusatz	0.0077			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Heptane	0.0138			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Hydrochloric acid	1.62			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Hydrogen peroxide	0.055			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for cleaning of water.	Input	Refined resource	Iron trichloride	0.0214			kg	Technosphere	
Date concieved: 1995 Data type: Estimated from similarity Notes: Used for surface treatment	Input	Refined resource	KAu(CN)2	0.169			kg	Technosphere	
Date concieved: 1995- Data type: Economical information Notes: A photo chemical. Rest products from the substance is taken care of by Stena Miljö.	Input	Refined resource	Kodak Polimax Fix	0.0165			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Nickel chloride	0.005			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Nickel sulphate	0.0571			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Nicoflex special	0.00385			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Nitric acid	0.325			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Lubricating oil 78,6%, which is used in the mecanical work-shop and Alusol (Mod oxazolidin >3%, highly refined mineral oil, amine boronate, vegetable rich oil, benso triazole, polyglycoleter and deionized water) 20,4% and Plibond (methyl ethyl ketone and polymer plastic) 1,00%, both used as cutting liquid.	Input	Refined resource	Oil	0.151			kg	Technosphere	
Date concieved: 1995 Data type: Economical information	Input	Refined resource	Oxalic acid	0.00385			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for cleaning.	Input	Refined resource	Phenyl sulfonate	0.0169			kg	Technosphere	

Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Phosphoric acid	0.00808			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Porol	0.00385			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Potassium cyanide	0.0132			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment	Input	Refined resource	Potassium hydroxide	0.0027			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Roblack Fe	0.0115			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Rostrip M-20	0.00923			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Product name: Alkosan sanitet. Used for cleaning.	Input	Refined resource	Sanitary cleaners	0.0148			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for cleaning.	Input	Refined resource	Sapogenat	0.0154			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Sodium bicarbonate	0.0077			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Sodium bichromate	0.0154			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Sodium bisulphite	0.077			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Sodium cyanide	0.00469			kg	Technosphere	
Date concieved: 1995 Data type: Economical information	Input	Refined resource	Sodium ditionite	0.00385			kg	Technosphere	
Date concieved: 1995 Data type: Estimated Notes: 84,5 % is used for water cleaning and has the concentration 40% NAOH, 8,96% is solid and 6,51% consist of Planalbeize 1414 Sodium hydroxid. The last two are used for surface treatment	Input	Refined resource	Sodium hydroxide	0.472			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for cleaning of water.	Input	Refined resource	Sodium hypochlorite	0.135			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: The products used are: DT 010 3,22% DT 139 0,402% ET 103 0,101% FE 050 2,01% Candorinse 6 0,201% Candoclene SN 1,51% Emulgator 100 0,201% Defoaming 30 0,201% Condoclene SA 0,503% Isopropylalkohol 4,79% NT 001 36,2% RD 020-0214 1,01% RV 031 0,805% FG 120 20,8% DJ 130 2,51% EG 121 6,84% AT 032 3,22% Thinner 3,22% S 3 3,08% Ethyl acetate 1,81% ET 122 9,15%	Input	Refined resource	Solvents	0.382			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: The product used are: Compound LQ9 1,13% Compbound SIC 3,01% Methylenchloride 80,8% Trichlorethylene 15,1%	Input	Refined resource	Solvents	0.51			kg	Technosphere	
Date concieved: 1995 Data type: Economical information	Input	Refined resource	Sorbitol	0.0192			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Spanol W	0.00385			l	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Sugar	0.00385			kg	Technosphere	

Date concieved: 1995 Data type: Economical information Notes: The acid has the concentrationof 98% H2SO4. The acid is used for water cleaning and surface treatment.	Input	Refined resource	Sulphuric acid	0.243			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Used for surface treatment.	Input	Refined resource	Tiefschwarz	0.00246			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Notes: Product name: Avanti tvättvax. Used for cleaning.	Input	Refined resource	Washing waxes	0.0119			kg	Technosphere	
Date concieved: 1995 Data type: Monitored data, discrete Method: The arithmetic average value is given by five spiecements. Each spiecement is accumulated during two mounth. The aluminium is analysed according to Swedish standard ss 028152-2 by the laboratory KM-Lab (Box 1083, 581 10 Linköping, Sweden, Phone +46 (0)13 233600). The result is shown as a concentration, but given the two mounth waterflow it is converted to an amount representing the measuring periode. The five amounts sums up to the total emission for 1995. The instrument for taking of spiecements is controlled and calibrated continously. Three employees has passed a course in taking of spiecements. Notes: The water is led to Ryaverket (the local sewage treatment works).	Output	Emission	Al	2180			mg	Water	
Date concieved: 1995 Data type: Monitored data, discrete Method: The arithmetic average value is given by five spiecements. Each spiecement is accumulated during two mounth. The cadmium is analysed according to Swedish standard ss 028152-2 by the laboratory KM-Lab (Box 1083, 581 10 Linköping, Sweden, Phone +46 (0)13 233600). The result is shown as a concentration, but given the two mounth waterflow it is converted to an amount representing the measuring periode. The five amounts sums up to the total emission for 1995. The instrument for taking of spiecements is controlled and calibrated continously. Three employees has passed a course in taking of spiecements. Notes: The water is led to Ryaverket (the local sewage treatment works).	Output	Emission	Cd	17.6			mg	Water	
Date concieved: 1995 Data type: Monitored data, discrete Method: The arithmetic average value is given by five spiecements. Each spiecement is accumulated during two mounth. The chromium is analysed according to Swedish standard ss 028152-2 by the laboratory KM-Lab (Box 1083, 581 10 Linköping, Sweden, Phone +46 (0)13 233600). The result is shown as a concentration, but given the two mounth waterflow it is converted to an amount representing the measuring periode. The five amounts sums up to the total emission for 1995. The instrument for taking of spiecements is controlled and calibrated continously. Three employees has passed a course in taking of spiecements. Notes: The water is led to Ryaverket (the local sewage treatment works).	Output	Emission	Cr	1330			mg	Water	
Date concieved: 1995 Data type: Monitored data, discrete Method: The arithmetic average value is given by five spiecements. Each spiecement is accumulated during two mounth. The copper is analysed according to Swedish standard ss 028152-2 (margin of error +/- 5-20%)	Output	Emission	Cu	464			mg	Water	

by the laboratory KM-Lab (Box 1083, 581 10 Linköping, Sweden, Phone +46 (0)13 233600). The result is shown as a concentration, but given the two mounth waterflow it is converted to an amount representing the measuring periode. The five amounts sums up to the total emission for 1995. The instrument for taking of spiecements is controlled and calibrated continously. Three employees has passed a course in taking of spiecements. Notes: The water is led to Ryaverket (the local sewage treatment works).									
Date concieved: 1995 Data type: Monitored data, discrete Method: The arithmetic average value is given by five spiecements. Each spiecement is accumulated during two mounth. The nickel is analysed according to Swedish standard ss 028151 by the laboratory KM-Lab (Box 1083, 581 10 Linköping, Sweden, Phone +46 (0)13 233600). The result is shown as a concentration, but given the two mounth waterflow it is converted to an amount representing the measuring periode. The five amounts sums up to the total emission for 1995. The instrument for taking of spiecements is controlled and calibrated continously. Three employees has passed a course in taking of spiecements. Notes: The water is led to Ryaverket (the local sewage treatment works).	Output	Emission	Ni	2940			mg	Water	
Date concieved: 1995 Data type: Monitored data, discrete Method: The arithmetic average value is given by five spiecements. Each spiecement is accumulated during two mounth. The led is analysed according to Swedish standard ss 028152-2 by the laboratory KM-Lab (Box 1083, 581 10 Linköping, Sweden, Phone +46 (0)13 233600). The result is shown as a concentration, but given the two mounth waterflow it is converted to an amount representing the measuring periode. The five amounts sums up to the total emission for 1995. The instrument for taking of spiecements is controlled and calibrated continously. Three employees has passed a course in taking of spiecements. Notes: The water is led to Ryaverket (the local sewage treatment works).	Output	Emission	Pb	124			mg	Water	
Date concieved: 1995 Data type: Monitored data, discrete Method: The arithmetic average value is given by five spiecements. Each spiecement is accumulated during two mounth. The zink is analysed according to Swedish standard ss 028152-2 by the laboratory KM-Lab (Box 1083, 581 10 Linköping, Sweden, Phone +46 (0)13 233600). The result is shown as a concentration, but given the two mounth waterflow it is converted to an amount representing the measuring periode. The five amounts sums up to the total emission for 1995. The instrument for taking of spiecements is controlled and calibrated continously. Three employees has passed a course in taking of spiecements. Notes: The water is led to Ryaverket (the local sewage treatment works).	Output	Emission	Zn	104			mg	Water	
	Output	Product	Camera	1			pce	Technosphere	
Date concieved: 1995 Data type: Economical information Method: Weighed by the waste disposal company. Notes: Disposed by RECI	Output	Residue	Acid waste	0.352			kg	Technosphere	

Date concieved: 1995 Method: Weighed by the waste disposal company. Notes: Disposed by RECI	Output	Residue	Alkaline waste	0.0048			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Method: Weighed by the waste disposal company. Notes: Disposed by RECI	Output	Residue	Heavy metal	1.456			kg	Technosphere	
Date concieved: 1995 Notes: Conventional industrial waste is disposed by Renhållningsverket (the local waste disposal company). No amount is given.	Output	Residue	Industrial waste	0			g	Technosphere	
Date concieved: 1995 Data type: Economical information Method: Weighed by the waste disposal company. Notes: Waste from the surface treatment department. Disposed by RECI	Output	Residue	Industrial waste	0.3424			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Method: Weighed by the waste disposal company. Notes: Disposed by RECI	Output	Residue	Oil emulsion	0.0544			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Method: Weighed by the waste disposal company. Notes: Disposed by RECI	Output	Residue	Waste containing cyanide	0.1024			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Method: Weighed by the waste disposal company. Notes: From photo lab Disposed by Stena Miljö.	Output	Residue	Waste developers	0.016352			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Method: Weighed by the waste disposal company. Notes: From photo lab Disposed by Stena Miljö.	Output	Residue	Waste fixing	0.016672			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Method: Weighed by the waste disposal company. Notes: Disposed by RECI	Output	Residue	Waste oil	0.06784			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Method: Weighed by the waste disposal company. Notes: Also contains enamel Disposed by RECI	Output	Residue	Waste paint	0.03264			kg	Technosphere	
Date concieved: 1995 Data type: Economical information Method: Weighed by the waste disposal company. Notes: 97,4% chlorinated solvents Disposed by RECI	Output	Residue	Waste solvents	0.286144			kg	Technosphere	

About Inventory

Publication	The environmental report from Victor Hasselblad AB for 1995, The Environmental Administration in the municipality of Göteborg -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .

Practitioner	Wilén, Stig - Victor Hasselblad AB Box 220 401 23 Göteborg Sweden.
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	The material used (optics and metal plates) for making cameras, magazines and accessories are not stated in the environmental report. Only the material used for treating the components are specified. For more information about the purchased amounts of material contact the company.
About Data	The average pH during 1995 was 8,5 and the average flow 50 m3/day.
Notes	

SPINE LCI dataset: Production of CAN fertiliser

Administrative

Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public

Technical System

Name	Production of CAN fertiliser
Functional Unit	1 kg of CAN fertiliser
Functional Unit Explanation	Suprasalpeter, N 28 (27,6 % N) Calcium ammonium nitrate (CAN)
Process Type	Gate to gate
Site	Hydro Agri AB Box 516 SE-261 24 Landskrona Sweden
Sector	Materials and components
Owner	Hydro Agri AB Box 516 SE-261 24 Landskrona Sweden
Technical system description	At the plant operated by Hydro Agri AB in Landskrona nitric acid is mixed with gaseous ammonia, forming an ammonium nitrate solution of 92 %. The solution is evaporated with steam generated in the nitric acid plant to a concentration of 96 % in a vacuum evaporator. Process steam from the exothermic neutralisation of ammonia and nitric acid contains some ammonia and ammonium nitrate droplets. The main part of the droplets is separated in a cyclone followed by a Brink mist filter and the nitrogen is brought back to the process. The treated steam from the neutralisation and steam from the vacuum evaporator are condensed with cooling water. The heated cooling water is then partly used for internal heating and partly transported to a district-heating network. The condensate is then treated in an osmosis set-up to partition the nitrogen compounds into one of two parts. The minor part containing nitrogen compounds is used as process water in the nitric acid plant and the other part is let out from the plant. The ammonium nitrate solution is mixed with small amounts of sulphuric acid for pH regulation and dolomite in a Frieder-King blender. The warm solution is then granulated with dolomite, crushed recycled material, dust from the dustfilter and in some cases calcium sulfate (gypsum). The granulate is then put into a rotary drier where the material is dried using hot air. Lastly the material is screened, cooled and coated. Air from the rotary drier, rotary coolers and from general dust extraction operations contains product dust and small amounts of ammonia. Most of the dust is separated in two textile filter barriers and the remaining tailgas is then released from the plant in a stack, 25 m above the roof of the plant. Reference: Miljörapport Hydro Agri AB Landskrona (1998). Official environmental report. Hydro Agri AB, Box 516, 261 24 Landskrona

System Boundaries

Nature Boundary	The system starts at the incoming factory gate and ends at the outgoing factory gate, i.e production of electricity, steam and supply materials are not included in this dataset.
Time Boundary	The data are figures for production in 1997.
Geographical Boundary	Hydro Agri AB in Landskrona, Sweden.
Other Boundaries	
Allocations	Total amount of emissions of ammonia to air were divided by total amounts of nitrogen in the fertilisers produced in1997 and then multiplied by nitrogen content of the product. An average value for emissions of particulates (fertiliser dust) to air was given in mg/h and the assumed yearly operating time was 85% of the time of year. Total emissions per year were then calculated and divided by total amounts of fertiliser produced in 1997. Total amount of nitrogen (NO-3-N, NH4+-N) in the water leaving the site includes, besides emissions of nitrogen from the processes also nutrient leakage from the nearby area. The amount of nitrogen released from the nitric acid plant, the fertiliser plant and the chemical storage was subtracted from the total amount. The share of the remaining amount originating from nutrient leakage was assumed to be 60% and 40% was assumed to originate from fertiliser dust. The share coming from nutrient leakage was not included in the total amounts of emissions, which then were divided by the total amount of nitrogen in fertiliser produced in 1997 and multiplied by the nitrogen content of the product. Production of district heat arise from neutralisation of nitric acid with ammonia and total amount of district heat produced at the fertiliser plant was therefore divided by the total amount nitrogen in the fertilisers produced in 1997 and then multiplied by the nitrogen content of the fertiliser product. Total amounts of steam and electricity consumed in the fertiliser plant was divided by total amounts of fertilisers produced in 1997.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New name: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.
Method	Amounts of ammonia and nitric acid consumed in the production of fertiliser was calculated by using the nitrogen content of the product and the molecular mass of nitric acid and ammonia respectively. Example: M(N): 14 g/mole M(NH3): 17 g/mole Þ 0.28 * (17g/mole) / (14 g/mole) /2 = 0.17 t NH3/t fertiliser Amount of dolomite consumed due to the fertiliser production was calculated by subtracting the amount of nitric acid and ammonia consumed from the amount fertiliser produced. Example: 1 - 0.17 t NH3/t fertiliser - 0.63 t HNO3/t fertiliser = 0.20 t dolomite /t fertiliser Total amount of emissions of ammonia to air were divided by total amounts of nitrogen in the fertilisers produced in1997 and then multiplied by nitrogen content of the product. An average value for emissions of particulates (fertiliser dust) to air was given in mg/h and the assumed yearly operating time was 85% of the time of year. Total emissions per year were then calculated and divided by total amounts of fertiliser produced in 1997. Total amount of nitrogen (NO-3-N, NH4+-N) in the water leaving the site includes, besides emissions of nitrogen from the processes also nutrient leakage from the nearby area. The amount of nitrogen released from the nitric acid plant, the fertiliser plant and the chemical storage was subtracted from the total amount. The share of the remaining amount originating from nutrient leakage was assumed to be 60% and 40% was assumed to originate from fertiliser dust. The share coming from nutrient leakage was not included in the total amounts of emissions, which then were divided by the total amount of nitrogen in fertiliser produced in 1997 and multiplied by the nitrogen

	content of the product. Production of district heat arise from neutralisation of nitric acid with ammonia and total amount of district heat produced at the fertiliser plant was therefore divided by the total amount nitrogen in the fertilisers produced in 1997 and then multiplied by the nitrogen content of the fertiliser product. Total amounts of steam and electricity consumed in the fertiliser plant was divided by total amounts of fertilisers produced in1997. See also ''Specific QMetaData''.
Literature Reference	Miljörapport Hydro Agri AB Landskrona (1998). Official environmental report. Hydro Agri AB, Box 516, 261 24 Landskrona Personal communication: Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Persson R (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100
Notes	The average pH during 1995 was 8,5 and the average flow of waste water is 50 m3/day.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Literature: Personal communication: Mats Karlsson (1998), Hydro Agri AB Landskrona, Sweden. tel: +46 418 76100 Notes: Bought from spot market in the Baltic sea, origin is Poland or Russia.	Input	Refined resource	Ammonia	0.17			kg	Technosphere	Sweden
	Input	Refined resource	District heat	-0.548			MJ	Technosphere	Sweden
Data type: Derived, mixed Method: The total amount of emissions nitrous oxides was divided by the total amount of nitric acid produced at the two plants in 1997. Notes: Ground dolomite.	Input	Refined resource	Dolomite	0.2			kg	Technosphere	Sweden
Notes:	Input	Refined resource	Electricity	0.072			MJ	Technosphere	Sweden
Method: Average values for emissions of nitric oxides from the two nitric acid plants at the site were given in kg/d and these values were therefor multiplied by 365, summarised and then divided by the total amount of nitric acid produced at the plants in 1997.	Input	Refined resource	Nitric acid	0.63			kg	Technosphere	Sweden
Notes:	Input	Refined resource	Steam	0.143			MJ	Technosphere	Sweden
	Output	Emission	NH3	0.2			g	Air	Sweden
Notes:	Output	Emission	N-tot	0.521			g	Water	Sweden
	Output	Emission	Particulates	0.0494			g	Air	Sweden
Notes: Suprasalpeter, N 28 (27,6 % N) CAN (calcium ammonium nitrate)	Output	Product	Nitrogen fertiliser	1			kg	Technosphere	Sweden

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources due to the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other, but to generate a thorough inventory of emissions and use of resources due to the production of different mineral fertilisers. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The data are applicable for production of CAN fertiliser produced and used in Sweden. It can be assumed that production of CAN in Sweden is representative for production of all CAN that is used in Sweden, but it is important to be aware of the fact that there may exist imports of CAN into Sweden.

	The dataset is included in an aggregated system for fertiliser production in Landskrona (cradle to gate).
About Data	The data are taken from a specific site in Sweden and are therefore reliable. The data are gathered from the official environmental report distributed by Hydro Agri AB in Landskrona and also from personal communication with people working there. There are only two sites in Sweden that produce CAN fertiliser and the site in Landskrona is representative for Swedish production of CAN.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of CAN fertiliser AGGR

Flow Chart

This data set transparently reported, including a flowchart where each process is individually described

Administrative	
Finished	Y
Date Completed	1999
Copyright	
Availability	

Technical System	
Name	Production of CAN fertiliser AGGR
Functional Unit	1 kg Nitrogen fertiliser
Functional Unit Explanation	
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The production route of CAN fertiliser produced at Hydro Agri AB in Landskrona can be seen in the aggregated activity window. For information about each separate production step, please see each included dataset. Emissions from transports, energy consumption and production of steam, district heat and electricity have been included in the system by using information and emission factors from the database in LCAiT 3.0. LCAiT 3.0 is a computer programme created by CIT Ekologik in Gothenburg for practitioners of life cycle assessments. Production/consumption of steam is assumed to replace/be produced by combustion of oil (efficiency of 0.90). Oil has been chosen as fuel source, as it in terms of emissions lies between coal and natural gas. Included transports and assumptions made regarding transports are described below (transports cannot be seen in the aggregated activity window). The ammonia used in production of fertilisers in Sweden is purchased at the spot market in the Baltic Sea. This ammonia mostly originates from Russia and Poland. The ammonia has been assumed to origin from the area around Moscow. It has been assumed that the ammonia is transported by train from Moscow to the harbour in Ventspils in Latvia (1000 km, train, diesel) and then transported by boat to Landskrona (400 km, ship, bulk carrier). Dolomite used at Hydro Agri AB in Landskrona comes from Hammerfall in Northern Norway. It is transported by truck (5 km, medium truck, rural, full) to a harbour close to Bodø, from where it is transported by boat (1800 km, ship, bulk carrier) to Landskrona.

Flowchart

Click on flowchart to open each data set description

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New name: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.
Method	Amounts of ammonia and nitric acid consumed in the production of fertiliser was calculated by using the nitrogen content of the product and the molecular mass of nitric acid and ammonia respectively. Example: M(N): 14 g/mole M(NH3): 17 g/mole Þ 0.28 * (17g/mole) / (14 g/mole) /2 = 0.17 t NH3/t fertiliser Amount of dolomite consumed due to the fertiliser production was calculated by subtracting the amount of nitric acid and ammonia consumed from the amount fertiliser produced. Example: 1 - 0.17 t NH3/t fertiliser - 0.63 t HNO3/t fertiliser = 0.20 t dolomite /t fertiliser Total amount of emissions of ammonia to air were divided by total amounts of nitrogen in the fertilisers produced in1997 and then multiplied by nitrogen content of the product. An average value for emissions of particulates (fertiliser dust) to air was given in mg/h and the assumed yearly operating time was 85% of the time of year. Total emissions per year were then calculated and divided by total amounts of fertiliser produced in 1997. Total amount of nitrogen (NO-3-N, NH4+-N) in the water leaving the site includes, besides emissions of nitrogen from the processes also nutrient leakage from the nearby area. The amount of nitrogen released from the nitric acid plant, the fertiliser plant and the chemical storage was subtracted from the total amount. The share of the remaining amount originating from nutrient leakage was assumed to be 60% and 40% was assumed to originate from fertiliser dust. The share coming from nutrient leakage was not included in the total amounts of emissions, which then were divided by the total amount of nitrogen in fertiliser produced in 1997 and multiplied by the nitrogen content of the product. Production of district heat arise from neutralisation of nitric acid with ammonia and total amount of district heat produced at the fertiliser plant was therefore divided by the total amount nitrogen in the fertilisers produced in 1997 and then multiplied by the nitrogen content of the fertiliser product. Total amounts of steam and electricity consumed in the fertiliser plant was divided by total amounts of fertilisers produced in1997. See also ''Specific QMetaData''.
Literature Reference	Miljörapport Hydro Agri AB Landskrona (1998). Official environmental report. Hydro Agri AB, Box 516, 261 24 Landskrona Personal communication: Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Persson R (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100
Notes	The average pH during 1995 was 8,5 and the average flow of waste water is 50 m3/day.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Dolomite	0.2			kg	Ground	
Notes: Emissions from extraction and final use (combustion) of hard coal are included in the outputs.	Input	Natural resource	Hard coal	1.34E+00			MJ	Ground	
Notes: (>100 kW). Emissions from extraction and final use (combustion) of natural gas are included in the outputs.	Input	Natural resource	Natural gas	1.07E+01			MJ	Ground	
Notes: Emissions from extraction and combustion of heavy oil are included in the outputs.	Input	Natural resource	Oil, heavy fuel	1.53E+00			MJ	Ground	

Notes: Emissions from combustion of diesel are included in the outputs.	Input	Refined resource	Diesel	2.53E-01			MJ	Technosphere	
Notes: ''Negative'' emissions from avoided production of district heat are included in the outputs.	Input	Refined resource	District heat	-2.06E+00			MJ	Technosphere	Sweden
Notes: Emissions from production of electricity are included in the outputs.	Input	Refined resource	Electricity	1.02E-01			MJ	Technosphere	Europe
Notes: Emissions from production of electricity are included in the outputs.	Input	Refined resource	Electricity	7.09E-01			MJ	Technosphere	Sweden
Notes: Emissions from combustion of fuel oil are included in the outputs.	Input	Refined resource	Fuel oil, ship (2-stroke)	2.58E-02			MJ	Technosphere	
	Output	Emission	Acetaldehyde	1.07E-05			g	Air	
	Output	Emission	Acetylene	5.78E-04			g	Air	
	Output	Emission	Al	2.53E-04			g	Air	
	Output	Emission	Aldehydes	1.79E-06			g	Air	
	Output	Emission	Alkanes	1.26E-03			g	Air	
	Output	Emission	Alkenes	6.14E-04			g	Air	
Notes: (C9-C10)	Output	Emission	Aromates	2.33E-04			g	Air	
Notes: (C9-C10)	Output	Emission	Aromates	8.25E-06			g	Water	
	Output	Emission	As	5.23E-06			g	Water	
	Output	Emission	As	9.16E-05			g	Air	
	Output	Emission	B	1.40E-04			g	Air	
	Output	Emission	Be	9.38E-06			g	Air	
	Output	Emission	Benzene	6.06E-03			g	Air	
	Output	Emission	Benzo(a)pyrene	1.70E-07			g	Air	
	Output	Emission	BOD	4.98E-06			g	Water	
	Output	Emission	Butane	7.42E-03			g	Air	
	Output	Emission	Ca	1.23E-04			g	Air	
	Output	Emission	Cd	2.53E-06			g	Water	
	Output	Emission	Cd	7.34E-05			g	Air	
	Output	Emission	CH4	8.69E-01			g	Air	
	Output	Emission	Cl-	2.26E+00			g	Water	
	Output	Emission	CN-	1.25E-05			g	Air	
	Output	Emission	CN-	1.57E-06			g	Water	
	Output	Emission	Co	1.76E-04			g	Air	
	Output	Emission	Co	4.00E-07			g	Water	
	Output	Emission	CO	-9.75E-02			g	Air	
	Output	Emission	CO2	9.18E+02			g	Air	
	Output	Emission	COD	1.26E-06			g	Water	
	Output	Emission	Cr	4.93E-06			g	Water	
	Output	Emission	Cr	5.80E-04			g	Air	
	Output	Emission	Cr3+	3.29E-05			g	Water	
	Output	Emission	Cr3+	-6.50E-05			g	Air	
	Output	Emission	Cu	-1.24E-08			g	Water	
	Output	Emission	Cu	4.86E-04			g	Air	
	Output	Emission	Dioxin	2.09E-10			g	Air	
	Output	Emission	Dissolved solids	4.35E-02			g	Water	
	Output	Emission	DOC	3.19E-13			g	Water	
	Output	Emission	Ethane	1.74E-03			g	Air	
	Output	Emission	Ethene	3.48E-03			g	Air	
	Output	Emission	F-	6.76E-04			g	Water	
	Output	Emission	Fe	2.76E-04			g	Air	
	Output	Emission	Fe	5.79E-03			g	Water	
	Output	Emission	Formaldehyde	1.84E-03			g	Air	
	Output	Emission	F-tot				g	Air	
	Output	Emission	H+	3.50E-05			g	Water	
	Output	Emission	H2S	1.06E-05			g	Air	
	Output	Emission	H2S	5.14E-08			g	Water	
	Output	Emission	Hazardous waste	8.07E+01			g	Technosphere	
	Output	Emission	HC	2.45E-05			g	Water	
	Output	Emission	HCl	6.27E-02			g	Air	
	Output	Emission	Heavy metals	3.37E-19			g	Air	
	Output	Emission	HF	3.31E-03			g	Air	

	Output	Emission	Hg	4.21E-06			g	Air	
	Output	Emission	Highly active rad ac waste	3.21E-03			g	Technosphere	
	Output	Emission	Industrial waste	6.15E+02			g	Technosphere	
	Output	Emission	Metals	1.17E-06			g	Air	
	Output	Emission	Metals	5.83E-06			g	Water	
	Output	Emission	Mn	4.85E-05			g	Water	
	Output	Emission	Mn	5.09E-04			g	Air	
	Output	Emission	Mo	1.40E-04			g	Air	
	Output	Emission	N2O	4.60E+00			g	Air	
	Output	Emission	Na	1.15E-03			g	Air	
	Output	Emission	NH3	2.00E-01			g	Air	
	Output	Emission	NH3	4.61E-08			g	Water	
	Output	Emission	Ni	1.69E-03			g	Air	
	Output	Emission	Ni	1.98E-05			g	Water	
	Output	Emission	NMVOC	3.67E-01			g	Air	
	Output	Emission	NO2	7.70E-01			g	Air	
	Output	Emission	NOx	1.56E+00			g	Air	
	Output	Emission	N-tot	6.69E-01			g	Water	
	Output	Emission	Oil	4.24E-02			g	Water	
	Output	Emission	Organics	3.57E-06			g	Air	
	Output	Emission	Organics	3.76E-02			g	Water	
	Output	Emission	PAH	1.08E-04			g	Air	
	Output	Emission	Particulates	2.30E-01			g	Air	
	Output	Emission	Pb	1.90E-05			g	Water	
	Output	Emission	Pb	4.10E-04			g	Air	
	Output	Emission	Pentane	1.27E-02			g	Air	
	Output	Emission	Phenol	7.98E-15			g	Water	
	Output	Emission	Phosphate	1.56E-05			g	Water	
	Output	Emission	PO43-	1.27E-04			g	Water	
	Output	Emission	Propane	3.31E-03			g	Air	
	Output	Emission	Propene	5.68E-04			g	Air	
	Output	Emission	P-tot	9.29E-07			g	Water	
	Output	Emission	Radioactive emissions	-6.34E+03			kBq	Water	
	Output	Emission	Radioactive emissions	-6.75E+05			kBq	Air	
	Output	Emission	Radioactive waste	1.34E-03			g	Technosphere	
	Output	Emission	Rn-222	5.84E+03			Bq	Air	
	Output	Emission	Salt	1.73E-02			g	Water	
	Output	Emission	Sb	5.61E-09			g	Water	
	Output	Emission	Sb	5.67E-05			g	Air	
	Output	Emission	Se	6.53E-05			g	Air	
	Output	Emission	Sn	-1.76E-06			g	Water	
	Output	Emission	Sn	3.19E-08			g	Air	
	Output	Emission	SO2	1.36E+00			g	Air	
	Output	Emission	SO3				g	Air	
	Output	Emission	SO42-	1.14E-01			g	Water	
	Output	Emission	Solid waste				g	Technosphere	
	Output	Emission	Sr	1.44E-06			g	Air	
	Output	Emission	Sr	2.14E-04			g	Water	
	Output	Emission	Susp solids	7.06E-04			g	Water	
	Output	Emission	Th	2.28E-08			g	Air	
	Output	Emission	Tl	3.94E-09			g	Air	
	Output	Emission	Toluene	2.28E-03			g	Air	
	Output	Emission	U	2.19E-08			g	Air	
	Output	Emission	V	1.31E-06			g	Water	
	Output	Emission	V	4.42E-03			g	Air	
	Output	Emission	VOC	1.18E-02			g	Air	
	Output	Emission	Xylene	1.18E-04			g	Air	
	Output	Emission	Zn	2.51E-05			g	Water	
	Output	Emission	Zn	5.34E-04			g	Air	
Notes: CAN fertiliser (Calcium ammonium nitrate).	Output	Product	Nitrogen fertiliser	1			kg	Technosphere	

About Inventory	
Publication	
Intended User	
General Purpose	
Detailed Purpose	
Commissioner	
Practitioner	
Reviewer	
Applicability	
About Data	
Notes	

SPINE LCI dataset: Production of clean bearing steel

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Production of clean bearing steel
Functional Unit	1000 kg ingot mould
Functional Unit Explanation	
Process Type	Gate to gate
Site	Ovako Steel AB SE-813 82 Hofors
Sector	Materials and components
Owner	Ovako Steel AB SE-813 82 Hofors
Technical system description	This activity is a process step included in the whole system activity ''Production of bearing rings'' and the system activity ''Production of bearing rollers (á 9.2 kg)'' (both can be found in the SPINE@CPM database). This gate-to-gate activity describes how steel ingot (used as raw material for bearing rings and rollers) is produced at the steel mill at Ovako Steel AB in Hofors. Roller bearings must be produced from extremely clean steel that possesses maximum fatigue strength. The steel produced at Ovako Steel AB in Hofors, Sweden, the raw material for the outer and inner rings, is completely produced from scrap. When the scrap arrives at Ovako Steel AB in Hofors it is sorted according to quality and alloy elements. The scrap is melted in an electric arc furnace where oxygen and carbon is added. The addition of oxygen and carbon makes the slag porous and in turn makes the process more effective. When the scrap is completely melted the slag is removed and the melt is poured into a ladle furnace where the steel is degassed and final adjustments of the alloys are made. The steel is then teemed uphill into ingot moulds. The moulds are finally removed. --- This dataset is an updated version of the previous dataset of ''Production of bearing steel''

	made by Åsa Ekdahl (also available at SPINE@CPM). Ovako Steel AB has made some improvements in the process and new data has been obtained for all process steps.

System Boundaries

Nature Boundary	The steel ingot is 100 % made from scrap and is not seen as a resource, but comes from the technosphere. The steel scrap from the process is recycled within the process and is not seen as waste, but a co-product to the technosphere.
Time Boundary	All data refers to year 1999. No changes are planned for the nearest future.
Geographical Boundary	The steel production takes place at the steel mill at Ovako Steel AB in Hofors, Sweden.
Other Boundaries	The electricity production is NOT included for the activity and must be followed from the cradle in order to get a correct result. The production of light fuel oil must be traced from the cradle, and is NOT included in this dataset. Production of raw material is not included. Waste treatment is not included. Subsystems concerning employees are not included. Transports are not included.
Allocations	Allocations have been made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New name: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.
Method	The data has been gathered from interviews with the environmental manager Eva-Maria Arvidsson at OVAKO Steel AB in Hofors. Meassurements but also estimations has been made by her.
Literature Reference	Miljörapport Hydro Agri AB Landskrona (1998). Official environmental report. Hydro Agri AB, Box 516, 261 24 Landskrona Personal communication: Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Persson R (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100
Notes	The average pH during 1995 was 8,5 and the average flow of waste water is 50 m3/day.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Al	1.46			kg	Ground	
	Input	Refined resource	Alumet	2.78			kg	Technosphere	
	Input	Refined resource	Carbon	22.62			kg	Ground	
	Input	Refined resource	Electricity	493.15			kWh	Technosphere	Sweden
	Input	Refined resource	Electrode	3.4			kg	Technosphere	
	Input	Refined resource	Ferro Molybdenum (FeMo)	0.7			kg	Technosphere	
	Input	Refined resource	Ferro Sulphur (FeS)	0.27			kg	Technosphere	
	Input	Refined resource	Ferroboron (FeB)	0.65			g	Technosphere	
	Input	Refined resource	Ferrochromium (FeCr)	13.9			kg	Technosphere	
	Input	Refined resource	Ferromanganese in ore	3.83			kg	Technosphere	
	Input	Refined resource	Ferroniobium (FeNb)	1.2			g	Technosphere	
	Input	Refined resource	Ferrosilicon (FeSi)	4.26			kg	Technosphere	
	Input	Refined resource	Ferrotitanium (FeTi)	0.004			kg	Technosphere	
	Input	Refined resource	Ferrovanadium (FeV)	0.07			kg	Technosphere	

	Input	Refined resource	Ingot Mould	10.1			kg	Technosphere	
	Input	Refined resource	Light fuel oil	0.295			MJ	Technosphere	
	Input	Refined resource	Lime	27.78			kg	Ground	
	Input	Refined resource	Merchant Scrap	723.4			kg	Technosphere	
	Input	Refined resource	Municipal water	58			kg	Technosphere	Sweden
	Input	Refined resource	Ni	1			kg	Ground	
	Input	Refined resource	Olivine	6.573			kg	Ground	
	Input	Refined resource	Oxygen	29.9			kg	Technosphere	
	Input	Refined resource	Refractory Lining	10.9			kg	Technosphere	
	Input	Refined resource	Steam	41			kg	Technosphere	Sweden
	Input	Refined resource	Steel scrap	385.27			kg	Technosphere	
	Input	Refined resource	Teeming Channel Bricks	4.25			kg	Technosphere	
	Output	Co-product	Drinking Water	57.6			kg	Technosphere	
	Output	Co-product	Ingot Mould	10.1			kg	Technosphere	
	Output	Co-product	Steel scrap	31.04			kg	Technosphere	
	Output	Emission	CO2	70			kg	Air	
	Output	Emission	Dioxin (TCDD)	0.0013			mg	Air	
	Output	Emission	NOx	0.14			kg	Air	
	Output	Emission	Particles	26.9408			kg	Air	
	Output	Emission	SO2	0.024			kg	Air	
	Output	Product	Ingot Mould	1000			kg	Technosphere	
	Output	Residue	Olivine	6.573			kg	Technosphere	
	Output	Residue	Particles	17.5			kg	Technosphere	
	Output	Residue	Refractory Lining	4.08			kg	Technosphere	
	Output	Residue	Refractory Lining	6.82			kg	Technosphere	
	Output	Residue	Sludge	2.649			kg	Technosphere	
	Output	Residue	Teeming Channel Bricks	4.256			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	LCA practitioners in general.
General Purpose	To fulfil a need for standard values to calculate energy use and exhaust emissions from production of clean bearing steel.
Detailed Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström. The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data are applicable to the production of bearing steel at the Steel Mill at Ovako Steel in Hofors, Sweden.
About Data	Data is gathered from interviews with Eva-Maria Arvidsson at Ovako Steel AB in Hofors. This dataset is an updated version of the previous dataset of ''Production of bearing steel'' made by Åsa Ekdahl (also available at SPINE@CPM). Ovako Steel AB has made some improvements in the process and new data has been obtained for all process steps.
Notes	

SPINE LCI dataset: Production of cooling fluid, R134a

Administrative	
Finished	Y
Date Completed	1995
Copyright	IVF-Institutet för verkstadsforskning
Availability	Public

Technical System	
Name	Production of cooling fluid, R134a
Functional Unit	1 kg R134a
Functional Unit Explanation	1 kg of the cooling agent R134a, a gas at room temperature and 1 atm pressure.
Process Type	Cradle to gate
Site	Unspecified
Sector	
Owner	Unspecified
Technical system description	Production of cooling fluid R134a from cradle to gate (product), including most of the subsystems for the production. R134a is used as cooling fluid for refrigeratiors, AC systems in cars etc. It replaces the older R12 and has no impact on the ozonelayer. But it has a hight impact on the greenhouse effect (1300 times higher than CO2). Brief description ------------------------ This study includes the production of R134a and the production of the two components needed for the process: Hydrogenfluoride and trchlorethylen. Furthermore, it includes the production of acetylene, which is a component in the process of making trichlorethylen. Detailed description ------------------------------ For the production of R134a. INPUTS 1. Hydrogen fluoride - see below. 2. Trichlorethylene - see below. 3. Help chemicals - these have been registered as an input without data from the cradle. OUTPUTS 1. Hydrogen flouride - The flow has not been followed to the cradle. 2. Hydrochloric acid - The flow has not been followed to the cradle. 3. Rest chemicals - The flow has not been followed to the cradle. Energy - Data about energyconsumption for the production of 1 kg of R134a comes from ICI. An assumption has been made that the energy comes from oil and natural gas (50/50), since these are the most common energy carriers in chemical industrial processes. Emissions from incineration of these energy carriers have been included in the activity sheet. Electricity consumption is added in the activity sheet but the environmental load from the production of electricity has not been included. For the production of the first component, hydrogen fluoride. INPUTS 1. Hydrogen gas - general data from literature. 2. Fluoric gas - no data has been found. The gas has been registered as an input without data from the cradle. Energy - data missing. For the production of the second component, trichlorethylene: INPUTS 1. Acetylene - three compounds are needed to produce acetylene, see further down. 2. Chloric gas - general data from literature. OUTPUTS

	1. Hydrogen chloride - general data from literature. The output has not been followed to the grave. Energy - data missing. For the production of acetylen, one of the components in trichlorethylene: INPUTS 1. Natural gas - general data from literature. Half of the gas is used for energy production for the process and half of the gas as a component. 2. Oil - general data from literature. 3. Sulphuric acid - no data has been found. The acid has been registered as an input without data from the cradle. Energy for the production of acetylen: Specific data has not been found, but general data from literature has been used to calculate the energy needed for the processes.

System Boundaries

Nature Boundary	The environmental impact from the system is defined as the natural resources passing over the system borders, and the emissions and waste passing out over the system borders. Production of electricity is not included in the system.
Time Boundary	The data was collected during 1995. Changes in processes will probably occur as time goes by. Landfills are assumed to part of the Technosphere as long as they are used.
Geographical Boundary	The environmental impact caused by the processes and transports in the system are included in the analysis regardless of where around the world they are located. The potential environmental effects included are also included regardless of where around the world they can arise. The final products are assumed to be used in Sweden.
Other Boundaries	For some subsystems data has not been found on production of components. These components are described as not having been followed from the cradle. For the same reason, some emissions and by-products are not accounted for as followed to the grave or cradle. For the production of R134a: Help chemicals - these have been registered as an input without data from the cradle. Hydrogen flouride - the flow has not been followed to the cradle, Hydrochloric acid - the flow has not been followed to the cradle, rest Non defined help chemicals - the flow has not been followed to the cradle. For the production of the first component, hydrogen fluoride: Fluoric gas - no data has been found. The gas has been registered as an input without data from the cradle. For the production of the second component, trichlorethylene: Hydrogen chloride - general data from literature. The output has not been followed to the grave. For the production of acetylen, one of the components in trichlorethylene: Sulphuric acid - no data has been found. The acid has been registered as an input without data from the cradle. The end use, recycling and the use of the product R134a is not included in this system. For information on flows of energy in the different subprocesses, please see ''Function''.
Allocations	By-products are listed, but no impacts are allocated to them. All impacts are allocated to the R134a.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, mixed
Represents	Average production of R1314a.
Method	In the overall project, data was collected from suppliers and from literature. Calculations on inventory data were made using the computer software LCA Inventory Tool, LCAiT. For this documentation in SPINE, the tables on pages 20-21 in IVF report 95833 have been used. The study was carried out during 1995.
Literature Reference	IVF publicaton 95832, Livscykelanalys med arbetsmiljö - En fallstudie av kylfrysar från Electrolux Delrapport 2: Data (IVF skrift 95833 - Produktion av R134a

Notes	---

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Bauxite	0.966			g	Ground	World
	Input	Natural resource	Crude oil	20.93			MJ	Ground	World
	Input	Natural resource	Hard coal	10.571			MJ	Ground	World
	Input	Natural resource	Hydro energy	1.1			MJ	Ground	World
	Input	Natural resource	Iron ore	0.977			g	Ground	World
	Input	Natural resource	Limestone	27.339			g	Ground	World
	Input	Natural resource	NaCl	1780			g	Ground	World
	Input	Natural resource	Natural gas	84.71			MJ	Ground	World
	Input	Natural resource	Sand	0.2940			g	Ground	World
	Input	Natural resource	Water	1490			g	Ground	World
Data type: Unspecified Method: Literature data Literature: Colection from ''IVF skrift 95833, Production av R!#¤a'' Notes: Data represents a non defined help chemicals for the process.	Input	Refined resource	Chemicals	2700			g	Technosphere	World
	Input	Refined resource	F2	794			g	Technosphere	World
	Input	Refined resource	H2SO4	42.7			g	Technosphere	World
	Input	Refined resource	NaOH	1.34			g	Technosphere	World
	Input	Refined resource	Natural gas	3.2			MJ	Technosphere	World
	Input	Refined resource	N-metylpyrrolidone	1.34			g	Technosphere	
	Input	Refined resource	O2	0.91			m3	Technosphere	World
Notes: Non defined help chemicals for R134a production process.	Output	By-product	Chemicals	138			g	Technosphere	World
	Output	By-product	coke	80.1			g	Technosphere	World
	Output	By-product	HCl	1510			g	Technosphere	World
	Output	By-product	HF	20.6			g	Technosphere	World
	Output	By-product	Mineral gas products	34.3			MJ	Technosphere	World
	Output	By-product	Steam	4.966			MJ	Technosphere	World
	Output	Emission	Acid as H+	0.607			g	Water	World
	Output	Emission	BOD	0.00449			g	Water	World
	Output	Emission	Cl-	61.92			g	Water	World
	Output	Emission	CO	1.6			g	Air	World
	Output	Emission	CO2	3620			g	Air	World
	Output	Emission	COD	0.0283			g	Water	World
	Output	Emission	Dust	6.25			g	Air	World
	Output	Emission	HCl	0.283			g	Air	World
	Output	Emission	HFC-134a	0.0012			g	Air	World
	Output	Emission	Hydrocarbons	0.0121			g	Water	World
	Output	Emission	Hydrocarbons	12.22			g	Air	World
	Output	Emission	Metals	0.00302			g	Air	
	Output	Emission	Metals	0.147			g	Water	World
	Output	Emission	N total	0.0022			g	Water	World
	Output	Emission	Na	4.117			g	Water	World
	Output	Emission	NOx	17.32			g	Air	World
	Output	Emission	Oil	0.0887			g	Water	World

	Output	Emission	Phenol	0.00131			g	Water	World
	Output	Emission	SO2	23.309			g	Air	World
	Output	Emission	SO42-	10.58			g	Water	World
	Output	Emission	Suspended solids	3.198			g	Water	World
	Output	Product	R134a	1			kg	Technosphere	World
	Output	Residue	Ashes	21.52			g	Technosphere	World
Notes: mixture of non-dagerous chemical wast. 99% inert chemicals.	Output	Residue	Chemicals	19.1424			g	Technosphere	World
	Output	Residue	Electricity	17.033			MJ	Technosphere	World
	Output	Residue	Industrial waste	1.523			g	Technosphere	World
	Output	Residue	Mineral waste	112.427			g	Technosphere	World
	Output	Residue	Nuclear energy	9.339			MJ	Technosphere	World
	Output	Residue	Other rest products	0.0117			g	Technosphere	World

About Inventory

Publication	IVF Publication 95832, Llivscykelanalys med arbetsmiljö - en fallstudie av kylfrysar från Electrolux. Delrapport 2: Data (IVF skrift 95833 - Produktion av R134a. ISSN 0349-0653/ISRN IVF - S - 95/832SE -- Data documented by: Caroline Sjöberg, Volvo Technological Developement Corporation; Dept. of Environment and Chemistry. Internal review of documentation by: Dan Wahlström, Volvo Technological Development Corporation, Dept. of Environment and Chemistry Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	Companies within the engineeri
General Purpose	Production of R134a is a subprocess in an overall LCA for refrigerators. The overall general purpose of the project was to: * evaluate the possibilities for including occupational health issues in LCAs * to compare the total environmental impact with the occupational health impact from the cradle to the grave for old models of refrigerators compared to new models. * to compare the total impact with respect to environmental issues and occupational healt issues from the cradle to the grave for refrigerators with different cooling agents * to compare the environmental impact with respect tot environment and occupational health issues for the three phases production, use and waste management.
Detailed Purpose	For the production of R134a: the purpose was to analyse the environmental load of an aircondition unit for refrigerators, AC in cars or other industrial applications.
Commissioner	Arbetslivsfonden - .
Practitioner	Electrolux AB, Volvo, IVL, IVF, CIT - Jan Kristoffersson, Electrolux AB Carl-Otto Nevén, Volvo Personvagnar Bengt Steen, IVL Elin Eriksson, CIT Lisa Person, CIT Tomas Rydberg, CIT Gunnar Bengtsson, IVF Richard Berglund, IVF Max Ma.
Reviewer	Not applicable -
Applicability	This documentation is based on the IVF publication 95833. All data from the report is included in the documentation. According to the IVF publication 95833, the numbers are representive for an average R134a production. According to the IVF publication 95833, individual processes, like the production of R134a, can be used separately from the main processes (production of refrigerators), which here has been done for R134a. The production processes for materials in the subsystems has only been included in some cases, when data has been available.Data comes mainly from literature, and from ICI, and is collected during 1995. The processes for production of R134a have not changed significantly from 1995 to 2000.
About Data	General for the whole study of refrigerators: Consumption of chemical materials and other man-made materials are listed as inflows not followed to the cradle if production of the materials are not included in the study. By-products, for which no benefits have been accounted, are listed as outflows which are not followed to the grave. One of the aims of the study was to find as site-specific data as possible from the suppliers

	to Electrolux. This, however, proved to be impossible since many suppliers refused to communicate these type of data. Instead, the project group focused on mapping out all materials flows and using data from literature. Production of R134a has been estimated from documents, from ICI Norden, Tore Kofstad, March 1995, and McKenzie, personal contact in March 1995. Production of tricloroethylen has been estimated from the ''McKensie, C, ICI UK,'' through a personal contact with the author. Production of acethylene has been estimated from ''Elvers et al. Ullman's encyclopedia of industrial chemistry, fifth complete revised edition, vol A1, page 112'' No comparative studies have been carried out. The data in the report 95833 from IVF is considered to be of good quality by Volvo Technological Development.
Notes	The following substance names have been changed from the nomenclature used by IVF to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Coal Hard coal Hydro Hydro energy Oil Crude oil EMISSIONS Old name New name Acidification eq. Acid as H+ CFCs HFC-134a HC Hydrocarbons Na+ Na Susp solids Suspended solids

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SPINE LCI dataset: Production of Copper Anodes

Administrative	
Finished	Y
Date Completed	1998
Copyright	The International Copper Association
Availability	Public

Technical System	
Name	Production of Copper Anodes
Functional Unit	1 kg of anode copper
Functional Unit Explanation	The purity of copper is approximately 99.5% .
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	Data received for this study are based on pyrometallurgical operations only. This activity includes: 1) Copper ore mining; 2) Copper ore concentrate preparation and delivery; 3) Production of matte copper 4) Production of blister copper and 5) Production of copper anodes. Production and use of electricity and fuel used in the processes are included. Below is a description of the included operations. -- 1) Ore mining -- The copper ore mining method used is determined by the size, shape and depth below the

	surface of the ore body. Most copper ores are mined by open pit mining in which large quarries are opened, the ore broken away from the deposits by use of explosives and shovelled into trucks. Actual energy requirements vary widely depending on the characteristics of the mine and ore handling techniques used. The type and the amount of ore deposit and the overlying rock and dirt and the depth of the seam below the surface, affect the level of energy needed for mining the ore. The data for copper mining have been received from three mining companies. The data cover the mining of 45 million tonnes of ore. -- 2) Ore concentrate preparation and delivery -- It is normal practice for mining companies to prepare or concentrate before shipping to reduce the amount of material to be transported. The data mainly relates to transportation of ore concentrate by rail and sea. Transporting the concentrate by sea is extensive. It is assumed that average shipping and rail transport distances were 10 000 km and 500 km respectively. The data covers preparation of 2 million tonnes of concentrate -- 3) Production of matte copper -- Here the ore concentrate, mixed with flux and other additives, is charged in a fuelfired smelting furnace where it is melted. The molten mass is allowed to separate into two layers. The upper slag layer, made up of iron silicate with less than 0,5% of copper, is normally discarded. The lower matte layer, with about 40% to 75% of copper, and containing most of original metal present, is transferred to the converting step to produce blister copper. -- 4) Production of blister copper -- During the production of blister copper the matte is converted to blister in a converter by oxidation in two stages. In the first stage iron sulphide is oxidised and fluxed to form slag which may contain copper (1-5%). The converter slag is ususally recycled back to the smelting furnace. With all the iron removed, the remaining copper sulphide is further oxidised to blister copper. --5) Production of copper anodes -- The blister copper from the converter is transferred to anode furnace to reduce the residual sulphur as well as the oxygen levels in the metal. The data cover the production of 1 million tonnes of copper anodes.

System Boundaries

Nature Boundary	Some of the data on air and water emissions was provided in a form which made it impractical to calculate emissions for unit mass of product output. For example, from an air emission value given in the units of mg/m3 of air, it is not possible to calculate the total emission unless the total volume of air is known and this is seldom measured in pactice. Therefor, where available, only emission values associated with the given amount of product made are used.
Time Boundary	The data comes from mining companies and producers of primary copper for the operations during the 12 month period in 1995 (information why the year 1995 was chosen is not available).
Geographical Boundary	The data comes mainly from European operations. Futher information of the geographical boundaries is not available.
Other Boundaries	The copper producing industry is international. A considerable transport of ore, concentrate and final products are done. The data mainly relates to transportation of ore concentrate by rail and sea. It is assumed that average shipping and rail transport distances were 10 000 km and 500 km respectively.
Allocations	The first thing that has been done to analyse this system is to break down the complex system into a series of separate sub-systems each of which produces a single product but which, when added together, exhibit the same charateristics as the original single system. In this study has co-product allocation and Stoichiometric allocation been applied. It is not often that practical processes exactly match for example the stoichiometric rules and an alternative method using mass must be applied.
Systems Expansions	Not applied

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, unspecified
Represents	Average production of R1314a.
Method	An LCA calculation of primary copper production. The tables that have been used are the tables 61, 63, 64, 65 and 66 in the Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998. For the following subjects has a slightly different name been use here in SPINE compaired from the original tables in the IAC report: In SPINE: In the IAC report: Iron Ore Iron Natural Gas Gas/Condensate NaCl Sodium Chloride HC Hydrocarbons Cr Chromium CH4 Methane Cu Cu++/Cu+++ Calcium Ca++ NO3-N NO3- Hazardous waste Regulated chemical

Literature Reference	Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998.
Notes	---

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Bauxite	31000			mg	Ground	
	Input	Natural resource	Bentonite	53			mg	Ground	
	Input	Natural resource	Calcium sulphate	530			mg	Ground	
	Input	Natural resource	Coal	1127000			mg	Ground	
	Input	Natural resource	Crude oil	220000			mg	Ground	
	Input	Natural resource	Dolomite	1700			mg	Ground	
	Input	Natural resource	Iron ore	72000			mg	Ground	
	Input	Natural resource	Lead	3			mg	Ground	
	Input	Natural resource	Lignite	21000			mg	Ground	
	Input	Natural resource	Limestone	130000			mg	Ground	
	Input	Natural resource	NaCl	6340			mg	Ground	
	Input	Natural resource	Natural gas	150000			mg	Ground	
	Input	Natural resource	Nitrogen	630			mg	Ground	
Notes: Includes bonded and elemental sulphur.	Input	Natural resource	Sulphur	990			mg	Ground	
Notes: This result covers Coal (1100000mg) and metalurgical coal (27 000 mg).	Input	Natural resource	Wood	350000			mg	Ground	
	Input	Natural resource	Zinc	4600			mg	Ground	
	Output	Emission	As	49			mg	Air	
	Output	Emission	BOD	1600			mg	Water	
	Output	Emission	Calcium	160			mg	Water	
	Output	Emission	CH4	3200			mg	Air	
	Output	Emission	Cl	250000			mg	Water	
	Output	Emission	CO	31000			mg	Air	
	Output	Emission	CO2	3800000			mg	Air	
	Output	Emission	COD	1300			mg	Water	
	Output	Emission	Cu	12			mg	Water	
	Output	Emission	Cu	230			mg	Air	
	Output	Emission	Dissolved solids	560000			mg	Water	
	Output	Emission	HC	4800			mg	Air	
	Output	Emission	HCl	490			mg	Air	
	Output	Emission	HF	24			mg	Air	
	Output	Emission	NH4	21			mg	Water	
	Output	Emission	NO3-N	71			mg	Water	
	Output	Emission	NOx	36000			mg	Air	
	Output	Emission	Pb	1100			mg	Air	
	Output	Emission	Pb	64			mg	Water	
	Output	Emission	SO4	98000			mg	Water	
	Output	Emission	Sulphur	3700			mg	Water	
	Output	Emission	Susp solids	21000			mg	Water	
	Output	Emission	Zn	150			mg	Air	
	Output	Product	Copper Anode	1			kg	Technosphere	
	Output	Residue	Ashes	550000			mg	Technosphere	
	Output	Residue	Hazardous waste	31000			mg	Technosphere	

	Output	Residue	Industrial waste	5900			mg	Technosphere	
	Output	Residue	Mineral waste	160000000			mg	Technosphere	

About Inventory

Publication	Ecoprofile of Primary Copper Production- A report for The International Copper Association By Dr. I. Boustead. 1998. -- Data documented by: Sofia Medin, Electrolux ESD Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose of this work was to produce life-cycle inventory data for the production of primary copper and the sub-processes based on data submitted by members of the International Copper Association from their own operations.
Detailed Purpose	The aim is to provide ''cradle to gate'' data for the production of copper anodes, which is a sub-process in the production of primary copper.
Commissioner	- The International Copper Association .
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	There is no recommendation of how to use the data from this report. This activity is part of a ''cradle to gate'' system for primary copper production. In the sequence of operations leading up to primary copper production there are six main stages involved. These are 1) Copper ore mining; 2) Copper ore concentrate preparation and delivery; 3) Production of matte copper; 4) Production of blister copper; 5) Production of copper anodes and 6) Production of primary copper. This activity only covers the stages 1) to 5). All six stages in the primary copper production have been described cumulatively in separate activities in the database.
About Data	Data received from participating companies show sometime wide variation with respect to metal contents of ore and various intermediate products such as concentrates, gas dust and scrap. Therefor has the following assumptions been made: 1. Copper content in ore. Where actual data on copper content of the ore were available these were used. Otherwise the content was calculated on the basis of mass flow. 2. Copper content of matte according to published literature is between 40% to 75%. The assumption made, where the copper content in matte was not derived from mass flow, is therefor 60 %. 3.Average copper content of blister was assumed to be 98,5%, based on published litterature. 4.Average copper content of copper anode was assumed to be 99.5% based om published literature. 5. There is also some loss of copper during ore preperation and the smelting and recovery processes. The loss can be calculated from the mass flow if accurate contents of the input and output materials where known.Where this is not possible, the loss is assumed to be 1% at each step of the sequence of operations. It is further assumed that there is another 4% loss of copper during the operational steps from ore preperation to electro-refining, making the total loss of copper to 5%.
Notes	The results in the report of the Ecoprofile study has been broken down into a number of categories, identifying the type of operation that gives rise to them. The categories are: 1. Fuel production 2. Fuel use 3. Process 4. Transport 5. Biomass (inputs and outputs associated with the use of biological materials such as wood)

SPINE LCI dataset: Production of copypaper. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Production of copypaper. ESA-DBP
Functional Unit	1000 kg of copypaper
Functional Unit Explanation	Unknown
Process Type	Other
Site	Unknown
Sector	Paper and paper products
Owner	Unknown
Technical system description	The process was investigated from cradle to gate except birchwood which was not tracked to cradle. Excerpt from the report, see 'Publication': ''The paper is assumed to be produced at an integrated pulp and paper manufacturer, which use exess heat from the production of pulp to dry the paper. An integrated pulp and paper manufacturer have no transport distance between the two processes.'' The process consists of 3 main steps: making paper, rolling it and cutting into pages. This process is included in the system described in: Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Manufacturing of CD-R (Compact Disc-Recordable). ESA-DBP - Manufacturing of CD-ROM (Compact Disc - Read Only Memory). ESA-DBP - Dioctyl phthalate (DOP) production. ESA-DBP - Cultivation and felling of trees for papermaking. ESA-DBP - Cardboard production (MDF based). ESA-DBP - Production of orthoxylene. ESA-DBP

System Boundaries	
Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) emissions to air, water and ground and also waste generation.
Time Boundary	1996
Geographical Boundary	Sweden
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1996
Data Type	Derived, unspecified
Represents	See 'Function'

Method	Excerpt from the report: ''To the data from the STFI database of wet pulp manufacturing data for the energy consumption for making paper, roll and cut it into pages have been added'' (NB: data for rolling and cutting steps come from personal communication)
Literature Reference	Swedish Pulp and Paper Research Institute (STFI) database (1996), Sweden personal communication with Jan Bresky (1996), Stora Research, Sweden
Notes	---

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Ground water	8.70E+01			m3	Water	Sweden
	Input	Refined resource	Birchwood	3.77E+00			m3	Technosphere	Sweden
	Input	Refined resource	CaCO3	5.40E+03			g	Technosphere	Sweden
	Input	Refined resource	CaO	9.00E+03			g	Technosphere	Sweden
	Input	Refined resource	Chelating agents	3.50E+02			g	Technosphere	Sweden
	Input	Refined resource	Defoamers	8.00E+02			g	Technosphere	Sweden
	Input	Refined resource	Electricity	4.35E+03			MJ	Technosphere	Sweden
	Input	Refined resource	Fuel oil	7.85E+02			g	Technosphere	Sweden
	Input	Refined resource	H2O2	6.80E+03			g	Technosphere	Sweden
	Input	Refined resource	H2SO4	2.67E+04			g	Technosphere	Sweden
	Input	Refined resource	MgSO4	1.20E+03			g	Technosphere	Sweden
	Input	Refined resource	Na2SO4	4.50E+02			g	Technosphere	Sweden
	Input	Refined resource	NaClO3	3.02E+04			g	Technosphere	Sweden
	Input	Refined resource	NaOH	3.39E+04			g	Technosphere	Sweden
	Input	Refined resource	O2	1.13E+04			g	Technosphere	Sweden
	Input	Refined resource	Other chemicals	2.10E+03			g	Technosphere	Sweden
	Output	By-product	Turpentine	1.60E+03			g	Technosphere	Sweden
	Output	Emission	AOX	5.90E+02			g	Water	Sweden
	Output	Emission	BOD7	1.01E+04			g	Water	Sweden
	Output	Emission	Chloride	2.24E+03			g	Water	Sweden
	Output	Emission	CO2	6.10E+04			g	Air	Sweden
	Output	Emission	COD	3.60E+04			g	Air	Sweden
	Output	Emission	H2S	3.00E+01			g	Air	Sweden
	Output	Emission	N	3.20E-01			kg	Water	Sweden
	Output	Emission	NOx	1.30E+03			g	Air	Sweden
	Output	Emission	Particulates	5.60E+02			g	Air	Sweden
	Output	Emission	Phosphorus	6.00E-02			kg	Water	Sweden
	Output	Emission	SO2	1.39E+04			g	Air	Sweden
	Output	Emission	SOx	1.10E+04			g	Air	Sweden
	Output	Emission	Susp solids	1.20E+03			g	Ground	Sweden
	Output	Product	Copypaper	1.00E+03			kg	Technosphere	Sweden
	Output	Residue	Ashes	3.70E+03			g	Technosphere	Sweden
	Output	Residue	Hazardous waste	1.20E+02			g	Technosphere	Sweden
	Output	Residue	Sludge	7.90E+03			g	Technosphere	Sweden
	Output	Residue	Waste	4.13E+04			g	Technosphere	Sweden

About Inventory

Publication	Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	The study was done for the purpose of master thesis.
Detailed Purpose	Excerpt from the report: ''The goal of this study is to undertake an life cycle assessment (LCA) of different alternatives for Ericsson to provide their customers with reference libraries to the Ericsson Consolo MD110 telephone exchange system. The different documentation alternatives investigated in this study are: plastic ring binders, paperbacks, CD-R records and CD-ROM records.''
Commissioner	Ericsson, Stockholm, Sweden - .
Practitioner	Torsten Beckman - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above

About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The inventory results for the whole life cycle (from cradle to grave) of binders, paperbacks, CD-Rs and CD-ROMs can be found in the reference report.

SPINE LCI dataset: Production of dimethylether from energy forest

Administrative	
Finished	Y
Date Completed	1996
Copyright	
Availability	Public

Technical System	
Name	Production of dimethylether from energy forest
Functional Unit	1 MJ
Functional Unit Explanation	The amounts in the table show the environmental load per MJ produced dimethylether.
Process Type	Gate to gate
Site	
Sector	Fuel
Owner	
Technical system description	Production of dimethylether using energy forest The wood from the energy forest (Willow) is dried and preheated before it is taken to the gasification. The gasification consists of two different steps, which are partial oxidation and pyrolysis. During the partial oxidation oxygen is added to the bio mass and carbon monoxide is produced. This is an exothermic reaction and therefore it emits heat. This heat is needed for the pyrolysis, during which carbondioxide and hydrogen are produced. The oxygen is separated from the air through distillation. The gas must also be cleansed from other kind of pollutants, because otherwise the methanol catalyst gets inactivated. The cleansed gas is compressed to synthesis-pressure (approximately 60 bar) and is then taken to the methanol-reactor.

System Boundaries	
Nature Boundary	The energy consumption and the emissions to air are accounted for. Also the raw material used is reported in the data.
Time Boundary	The most advanced technology is used
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Unspecified
Represents	See 'Function'
Method	Literature study of Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Literature Reference	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Notes	Information about the raw material Willow can be found in the activity ''Production of energy forest''

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Willow	1.7536			MJ	Forestral ground	
	Input	Refined resource	Electricity	0.086			MJ	Technosphere	
	Output	Emission	CO	16.141			mg	Air	
	Output	Emission	CO2	110192.63			mg	Air	
	Output	Emission	CO2	3.46			mg	Air	
	Output	Emission	HC	7.57			mg	Air	
	Output	Emission	NOx	9.78			mg	Air	
	Output	Emission	Susp solids	0.13			mg	Air	
	Output	Product	Dimethylethyl	1			MJ	Technosphere	

About Inventory

Publication	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5. -- Data documented by: Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Persons or companies intereste
General Purpose	
Detailed Purpose	The data are part of a study concerning alternative fuels
Commissioner	- KFB Komunikations Forsknings Beredningen Box 5706 Linnégatan 2 114 87 Stockholm Sweden.
Practitioner	Blinge Magnus, Arnäs P, Bäckström S, Furnander Å, Hovelius K - Department of Transportation and Logistics Chalmers University of Thechnology.
Reviewer	
Applicability	The data is taken from experimental production, and can therefore not be used with success to evaluate the present situation. Testing plants that need not function economically is not to be equalled to commercially producing plants. Because the environmental load is not proportional to the production amount this data should not be used on plants with much greater or smaller production. Data for the willow, which is used in to process can be found in SPINE in the activity ''Production of energy forest''.
About Data	
Notes	

SPINE LCI dataset: Production of Dowel Adhesive PVAC 3370

Administrative	
Finished	Y
Date Completed	2000-03-06
Copyright	Casco Products
Availability	Public

Technical System	
Name	Production of Dowel Adhesive PVAC 3370
Functional Unit	1 kg dry dowel adhesive Cascol 3370
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg dry dowel adhesive Cascol 3370 (PVAC 2270). The adhesiver is delivered with 47% dry content. As an average 82 g of package material per kg dry adhesive is delivered.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Dowel Adhesive PVAC 3370 (Cascol 3370) is a formulation of polyvinylacetate, fillers, solvent and additives. The adhesive is produced by Casco Products, Sweden. It is delivered in disposable containers (polyethylene/steel), polyethylene pailts or polypropylene drums. The production of the main raw materials is described below: 1. Natural gas production: The study includes winning, delivery to shore and storage. Natural gas is used in the production of raw materials for polyvinylacetate dispersion and solvent. 2. Crude oil production. The study includes winning, delivery to shore and storage. Crude oil is used in the production ofraw materials for polyvinylacetate dispersion and solvent. 3. There are various processes to produce acetylene and acetic acid, the main raw materials for vinylacetate production. It is not known which processes that are used in this case. 4. Vinylacetate is polymerised to polyvinylacetate with the help of radical forming catalysts. The temperature is often 70-80°C. In this case an emulsion polymerisation in the presence of wetting agent, protective colloides and catalyst is made. 5. Limestone is extracted from the earth, grinded and sieved to fit the specifications for the filler. Extraction an transports are accounted for. 6. Detailes of the process used for the solvent is not known. 7. The PVAc dispersion, filler, solvent and other additives are mixed together in the Casco Decorative Coatings' factory in Kristinehamn, Sweden. Overall information: Transports are included in the system.

System Boundaries	
Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally , in densly populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1997, beeing yearly averages where possible. No great changes after that are estimated. The data from Decorative Coatings factory in Kristinehamn are from 1998.
Geographical Boundary	The production of the raw materials is made on different sites in Europe. The mixing of the raw materials is made at Decorative Coatings' factory, Kristinehamn, Sweden.
Other Boundaries	An average of the packages for the product is included in this study. The transportation to the users, use and final desposal of the adhesive is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements.

	Water consumption was not included.
Allocations	Emissions and waste at the Decoraitve Coatings facory in Kristinehamn where the final mixing of teh raw materials is done are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from Environmental report 1998 and Production Statistics1998. Allocations were made on mass basis.
Literature Reference	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Notes	Information about the raw material Willow can be found in the activity ''Production of energy forest''

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Bauxite	0.2			g	Ground	
	Input	Natural resource	Coal	6.36			MJ	Ground	
	Input	Natural resource	Copper ore	1.1			g	Ground	
	Input	Natural resource	Crude oil	55.47			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	1.71			MJ	Ground	
	Input	Natural resource	Iron ore	16.2			g	Ground	
	Input	Natural resource	Limestone	27			g	Ground	
	Input	Natural resource	Minerals	67.9			g	Ground	
	Input	Natural resource	Natural gas	46.74			MJ	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	5.17			MJ	Ground	
	Input	Natural resource	Other fuel	1.22			MJ	Ground	
	Input	Natural resource	Uranium ore	0.56			g	Ground	
	Input	Natural resource	Wood	0.45			MJ	Ground	
	Output	Emission	Biocides	0.1			kg	Air	
	Output	Emission	CO	6.8			g	Air	
	Output	Emission	CO2	3137			g	Air	
	Output	Emission	COD	12.6			g	Water	
	Output	Emission	Dissolved solids	0.22			g	Water	
	Output	Emission	Dust	1.8			g	Air	
	Output	Emission	HCl	0.04			g	Air	
	Output	Emission	Hydrocarbons	5.7			g	Air	
	Output	Emission	Hydrogen	0.09			MJ	Air	
	Output	Emission	Ionics	6.4			g	Air	
	Output	Emission	Metals	0.31			g	Air	

	Output	Emission	Methane	9.1			g	Air	
	Output	Emission	N total	0.015			g	Water	
	Output	Emission	NOx	19			g	Air	
	Output	Emission	Phosphate as P2O5	0.1			g	Air	
	Output	Emission	SOx	15.4			g	Air	
	Output	Emission	Suspended solids	0.6			g	Water	
	Output	Emission	Total organic carbon	6.2			g	Water	
	Output	Emission	VOC	11.6			g	Air	
	Output	Product	PVAc 3370	1			kg	Technosphere	
	Output	Residue	Mineral waste	13.6			g	Technosphere	
	Output	Residue	Mixed industrial waste	4.3			g	Technosphere	
	Output	Residue	Non hazardous waste	167			g	Technosphere	
	Output	Residue	Slags and ash	4.7			g	Technosphere	
	Output	Residue	Sludge (Dry matter)	1			g	Technosphere	

About Inventory

Publication	-- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden Published in SPINE@CPM: 7 August 2001 --
Intended User	Users of PVAc dowel adhesive C
General Purpose	
Detailed Purpose	To provide LCI data to producers of carpentry, furniture and other wood products where PVAc dowel adhesives is used.
Commissioner	- Casco Products Box 11538, S-10061 Stockholm, Sweden .
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	Dowel adhesive Cascol 3370 is suitable for dowel gluing. It should always be used for indoor purposes. For more information about adhesives please contact Casco Products, phone no 46 8 743 4000.
About Data	For the final production of dowel adhesive 3370 all data originates from Decorative Coatings factory in Kristinehamn. For raw materials and auxilary materials suppliers have participated on terms that their data will be treated confidentially. For the production of polyvinylacetate cradle to gate data wer provided, for vinylacetate monomer , filler, solvent and additives cradle to gate data. For fuel data from APME Ecoprofiles are used.. Raw materials used are mentioned under ''Object of study/Functions) Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1995 from ''Annual Energy Review 1997'' (European comission) Building of the power plant is not included.
Notes	

SPINE LCI dataset: Production of energy forest

Administrative

Finished	Y
Date Completed	1997
Copyright	
Availability	Public

Technical System	
Name	Production of energy forest
Functional Unit	1 MJ
Functional Unit Explanation	The energy content in the produced energy forest (Willow)
Process Type	Gate to gate
Site	
Sector	Forestry
Owner	
Technical system description	Energy forest is the term for fast growing broad-leaf tree, as willow, grey alder, poplar and others. The most common is different kinds of willlow, because it gives a high production, and one can harvest several times before one needs to plant new trees, therefore willow is accounted for here. The whole cycle of growing willow takes 25 years. The cycle includes preparations, planting, six plantations of new trees and finally the process of breaking up the plantation after 25 years. When the trees are planted they are the fertilised with 15 kg/ha phosphorus and 40 kg/ha potassium. The second year, the plantation is fertilised with 45 kg/ha nitrogen, the third year with 125 kg/ha and the fourth year with 95 kg/ha. This information has been gathered through personal conversation with Stig Ledin at the Swedish Institute for Forestry of Deciduous. At the plantation the first, third and sixth year, the plants are fertilised with 60 kg/ha nitrogen. The second year the plantation is fertilised with 100 kg/ha nitrogen. The total energy consumption to prduce the fertilisers used during the 25 year period is 116824 MJ/ha Four litres of Roundup is sprayed on each ha before the planting is done. After the planting there is another pesticide sprayed on the ground, 2,5 litres Gardoprim per ha. The second year the procedure is repeated. The first year, at the plantations 2-6, four litres Roundup are sprayed on each ha, so that the whide disappears. The total amount of energy used to make the pesticides used during the 25 years-period is 4644 MJ/ ha. The production of the energy forest is estimated to be 10 tonnes per ha and year. Because the whole area can not be used the net harvest is 9 tonnes per ha and year. The harvest is done by direct splinting and is calculated to be totally 414000 kg/ha and then contain 50% water. The dry harvest is therefore 207000 kg per ha. After the first year the willow is cut 5400 kg/ha and the first real harvest can be taken the fifth year at approx. 27 000 kg/ha. There after another five harvests can be made every fourth year, at approx. 36 000 kg/ha each. The tractors used are assumed to be diesel driven. The diesel consumption is estimated be 633 litres per ha.

System Boundaries	
Nature Boundary	The boundary has been set at the forest edge, that is all activities run in the forest is accounted. Emissions to air and energy use is accounted for.
Time Boundary	The cycle of growing energy forest is 25 years.
Geographical Boundary	Sweden
Other Boundaries	It is not clear if the pesticides are accounted for. Energy contents in the used fertilisers and diesel are clearly accounted for in the table. Transportations of the wood and supply material, to and from the forest is not accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Estimated
Represents	See 'Function'
Method	Literature study of Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5. Most of the figures in the report origin from intervievs with farmrs and scientists, which work with energy forestry.
Literature Reference	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Notes	Information about the raw material Willow can be found in the activity ''Production of energy forest''

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: This item both contain the energy bound in the fertilicers used to grow 3361680 MJ Willow, and the energy contents of the diesel used in the forestry mashinery, with the efficiency of 20%	Input	Refined resource	NPK fertiliser	131170			MJ	Technosphere	Sweden
Notes: The energy content in the planted forest.	Input	Refined resource	Willow seed	3361680			MJ	Technosphere	
	Output	Emission	CO	1.822208			mg	Air	Sweden
	Output	Emission	CO2	2756.04			mg	Air	Sweden
	Output	Emission	N2O	29.13459			mg	Air	Sweden
	Output	Emission	NMHC	0.802402			mg	Air	Sweden
	Output	Emission	NOx	13.15486			mg	Air	Sweden
	Output	Emission	SOx	0.287809			mg	Air	Sweden
	Output	Emission	Susp solids	0.51637			mg	Air	Sweden
Data type: Estimated Notes: Energy content in the energy forest prodeced during the 25 year cycle.	Output	Product	Willow	3361680			MJ	Technosphere	

About Inventory

Publication	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5. -- Data documented by: Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Persons or companies intereste
General Purpose	
Detailed Purpose	The data are part of a study concerning alternative fuels
Commissioner	- KFB Komunikations Forsknings Beredningen Box 5706 Linnégatan 2 114 87 Stockholm Sweden.
Practitioner	Blinge Magnus, Arnäs P, Bäckström S, Furnander Å, Hovelius K - Department of Transportation and Logistics Chalmers University of Thechnology.
Reviewer	
Applicability	The data is built on estimations and therefore not very reliable. The subject energy forestry is fairly new, and there are therefore not a lot of relyable sorces avalable. The data should only be used for a period of time, because the progress of refining the growing of energy forest will continue in the near future.
About Data	The sustem bounderies are not clearly stated, and the information sorces are not specified.
Notes	

SPINE LCI dataset: Production of EPDM

Administrative	
Finished	Y
Date Completed	2001-03-01
Copyright	The report does not say if there are any copyrights.
Availability	Public

Technical System	
Name	Production of EPDM
Functional Unit	1 kg of EPDM
Functional Unit Explanation	EPDM is a monomer of ethylene and propylene. The functional unit of 1 kg EPDM is used because the total assessment is done on mass basis.
Process Type	Cradle to gate
Site	Sweden
Sector	Manufacturing
Owner	Sweden
Technical system description	This document describes the production of EPDM. EPDM is a monomer of ethylene and propylene. It is made from extraction of coal and crude oil.

System Boundaries	
Nature Boundary	The report does not say how other boundaries have been chosen.
Time Boundary	The report does not say how boundaries have been chosen.
Geographical Boundary	The production of EPDM is in Switzerland.
Other Boundaries	The extraction of all refined resources are included.
Allocations	The report does not say how allocation is made when the industry produce more than one product.
Systems Expansions	Not relevant.

Flow Data

General Activity QMetaData	
Date Conceived	2001-03-01--2001-04-01
Data Type	Derived, unspecified
Represents	Not relevant.
Method	Data is acquired from life cycle assessment of road from IVL Sweden Environmental Research Institute, March 2001
Literature Reference	''Life Cycle Assessment of Road, A Pilot Study for Inventory Analysis'', IVL Swedish Environmental Research Institute, Håkan Stripple, March 2001, Gothenburg, Sweden
Notes	Prepared for Ecolab by Annika Olsson. Checked by Malin Bogeskär.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Coal	5.6			MJ	Ground	Europe
	Input	Natural resource	Crude oil	21			MJ	Ground	Europe
	Input	Refined resource	Electricity	5			MJ	Technosphere	Europe
	Output	Emission	CO	0.8			g	Air	Europe
	Output	Emission	CO2	2328			g	Air	Europe
	Output	Emission	COD	20			g	Water	Europe
	Output	Emission	Methane	3.5			g	Air	Europe

	Output	Emission	N total	0.04			g	Water	Europe
	Output	Emission	N2O	0.05			g	Air	Europe
	Output	Emission	NMVOC	19			g	Air	Europe
	Output	Emission	NOx	4			g	Air	Europe
	Output	Emission	PAH	0.00003			g	Air	Europe
	Output	Emission	Particles	2.1			g	Air	Europe
	Output	Emission	SO2	5.7			g	Air	Europe
	Output	Product	EPDM	1			kg	Technosphere	Europe

About Inventory	
Publication	''Life Cycle Assessment of Road, A Pilot Study for Inventory Analysis'', IVL Swedish Environmental Research Institute, Håkan Stripple, March 2001, Gothenburg, Sweden -- Data documented by: Annika Olsson, 2002-10-10 Documentation reviewed by: Karolina Flemström, IMI, Chalmers University of Technology Published in SPINE@CPM: 2002-12-10 --
Intended User	The intendent user of this inv
General Purpose	The purpose is to inform interested parties about the environmental impact of EPDM.
Detailed Purpose	In this case the specific purpose is to use the inventory data for EPDM in a master´s thesis: Life-cycle assessment of two ventilation systems, by Annika Olsson, Chalmers University of Technology, 2002.
Commissioner	Lindab Ventilation AB - .
Practitioner	Olsson Annika - .
Reviewer	Bogeskär, Malin -
Applicability	The data is from a report from IVL Swedish Environmental Research Institute and there are no known limitation when using this data. IVL has received their data from ''Environmental Life-Cycle Inventories of Energy Systems, Bundesamt fur Energiewirtschaft, Sauter P Swiss Federal Institute of Technology, Zurich, Switzerland. EPDM, Ethylene propylene diene monomer, is a synthetic rubber. The polymer is resistant to ozone, UV radiation and temperature fluctuations. It is used for roofs, windows, facades and floors.
About Data	There are no information about how the data for the production of EPDM rubber has been collected or what boundaries and allocations are made.
Notes	

SPINE LCI dataset: Production of ethyl alcohol using energy forest and the CASH-method

Administrative	
Finished	Y
Date Completed	1996
Copyright	
Availability	

Technical System	
Name	Production of ethyl alcohol using energy forest and the CASH-method
Functional Unit	1 MJ
Functional Unit Explanation	The amounts in the table show the environmental load per MJ produced ethanol.

Process Type	Gate to gate
Site	
Sector	Fuel
Owner	
Technical system description	Ethyl alcohol can be produced of several kinds of renewable energy sources. The principle in the making of ethyl alcohol is to transform cellulose or farina in the raw material to fermentable sugar. After the fermentative process the water is removed through distillation and the remaining part is ethyl alcohol with high concentration. In the case studied here the producing plant is of the size 20 000 - 25 000 ton per year. This is considered to be a fairly small amount, which probably is not able to keep a plant in operation in economical terms. The raw material used is energy forest (Willow). The preparation consists of drying and grinding of the biomass, to enlarging the contact surface before the hydrolysis. The difference occurs in the hydrolysis. During the hydrolysis the sugar and lignin are separated. These data concern the CASH-method. In this method the hydrolys is done by adding sulfur dioxide and sulfuric acid. After this process the sugar is fermented into ethyl alcohol, which is separated through distillation. For further information see Von Sievers & Zacchi, 1993, A techno-economical comparison of three processes for the production of ethanol from wood, Kemisk Apparatteknik, LTH, 1993. In the process of making the ethyl alcohol biomass and by-products like methane are used to produce necessary processing steam. The only added source of energy is the energy forest and electricity. In the CASH-process also lignin pellets are produced.

System Boundaries

Nature Boundary	The energy consumption and the emissions to air are accounted for. Also the raw material used is reported in the data.
Time Boundary	The most advanced technology is used in the study.
Geographical Boundary	
Other Boundaries	
Allocations	The by-products are sorted in usable and unusable by-products. The unusable by-products are assumed to be useless, and are the energy use and emissions are allocated to the produced ethyl alcohol. The usable by-products carry their own environmental load.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1993
Data Type	Unspecified
Represents	Not relevant.
Method	Literature study of Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5, where the data are taken from Von Sievers & Zacchi, 1993, A techno-economical comparison of three processes for the production of ethanol from wood, Kemisk Apparatteknik, LTH, 1993. No information regarding the selection of the data is given in the report.
Literature Reference	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Notes	Prepared for Ecolab by Annika Olsson. Checked by Malin Bogeskär.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Willow	4.171			MJ	Forestral ground	
	Input	Refined resource	Electricity	0.136			MJ	Technosphere	
	Output	Emission	CO	16.571			mg	Air	
	Output	Emission	CO2	934.5			mg	Air	
	Output	Emission	HC	2.381			mg	Air	
	Output	Emission	NOx	41.582			mg	Air	
	Output	Emission	SO2	1.314			mg	Air	
	Output	Emission	Susp solids	0.209			mg	Air	

	Output	Product	Ethanol	1			MJ	Technosphere
	Output	Product	Lignin	1.32			MJ	Technosphere

About Inventory	
Publication	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5. -- Data documented by: Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Persons or companies intereste
General Purpose	
Detailed Purpose	The data was a part of a study concerning alternative fuels.
Commissioner	- KFB Komunikations Forsknings Beredningen Box 5706 Linnégatan 2 114 87 Stockholm Sweden.
Practitioner	Blinge Magnus, Arnäs P, Bäckström S, Furnander Å, Hovelius K - Department of Transportation and Logistics Chalmers University of Thechnology.
Reviewer	
Applicability	The data is taken from experimental production, and can therefore not be used with success to evaluate the present situation. Testing plants that need not function economically is not to be equalled to commercially producing plants. Because the environmental load is not proportional to the production amount this data should not be used on plants with much greater or smaller production. Data for the CHAP-method and the Enzyme-method are also available in SPINE. Data for production of the raw material, energy forest, are also available in SPINE.
About Data	The data in Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5 are taken from Von Sievers & Zacchi, 1993, A techno-economical comparison of three processes for the production of ethanol from wood, Kemisk Apparatteknik, LTH, 1993
Notes	

SPINE LCI dataset: Production of ethyl alcohol using energy forest and the CHAP-method

Administrative	
Finished	Y
Date Completed	1997
Copyright	
Availability	Public

Technical System	
Name	Production of ethyl alcohol using energy forest and the CHAP-method
Functional Unit	1 MJ
Functional Unit Explanation	The amounts in the table show the environmental load per MJ produced ethanol.
Process Type	Gate to gate
Site	
Sector	Fuel
Owner	

Technical system description	Ethyl alcohol can be produced of several kinds of renewable energy sources. The principle in the making of ethyl alcohol is to transform cellulose or farina in the raw material to fermentable sugar. After the fermentative process the water is removed through distillation and the remaining part is ethyl alcohol with high concentration. In the case studied here the producing plant is of the size 20 000 - 25 000 ton per year. This is considered to be a fairly small amount, which probably is not able to keep a plant in operation in economical terms. The raw material used is energy forest (Willow). The preparation consists of drying and grinding of the biomass, to enlarging the contact surface before the hydrolysis. The difference occurs in the hydrolysis. During the hydrolysis the sugar and lignin are separated. These data concern the CHAP-method. In this method the hydrolyse is done by adding highly concentrated hydrogen chloride, HCl. After this process the sugar is fermented into ethyl alcohol, which is separated through distillation. For further information Von Sievers & Zacchi, 1993, A techno-economical comparison of three processes for the production of ethanol from wood, Kemisk Apparatteknik, LTH, 1993.

System Boundaries

Nature Boundary	The energy consumption and the emissions to air are accounted for. Also the rawmaterial used is reported in the data.
Time Boundary	
Geographical Boundary	
Other Boundaries	
Allocations	The by-products are sorted in usable and unusable by-products. The unusable by-products are assumed to be useless, and the energy use and emissions are therefore allocated to the produced ethyl alcohol The usable by-products carry their own environmental load..
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1993
Data Type	Unspecified
Represents	Not relevant.
Method	Literature study of Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5, where the data are taken from Von Sievers & Zacchi, 1993, A techno-economical comparison of three processes for the production of ethanol from wood, Kemisk Apparatteknik, LTH, 1993. No further information regarding the selection of data is given in the report (Blinge 1997).
Literature Reference	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Notes	Prepared for Ecolab by Annika Olsson. Checked by Malin Bogeskär.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Electricity	0.086			MJ	Technosphere	
	Output	Emission	CO	52.36			mg	Air	
	Output	Emission	CO2	589.3			mg	Air	
	Output	Emission	HC	5.555			mg	Air	
	Output	Emission	NOx	117.998			mg	Air	
	Output	Emission	SOx	0.829			mg	Air	
	Output	Emission	Susp solids	0.132			mg	Air	
	Output	Product	Ethanol	1			MJ	Technosphere	

About Inventory

Publication	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5. -- Data documented by: Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology

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Intended User	Persons or companies intereste
General Purpose	
Detailed Purpose	The data are part of a study concerning alternative fuels
Commissioner	
Practitioner	Blinge Magnus, Arnäs P, Bäckström S, Furnander Å, Hovelius K - Department of Transportation and Logistics Chalmers University of Thechnology.
Reviewer	
Applicability	The data is taken from experimental production, and can therefore not be used with success to evaluate the present situation. Testing plants that need not function economically is not to be equalled to commercially producing plants. Because the environmental load is not proportional to the production amount this data should not be used on plants with much greater or smaller production. Data for the CASH-method and the Enzyme-method are also available in SPINE. Data regarding the raw material, energy forest, are available in SPINE. The activity is called ''Production of energy forest''.
About Data	
Notes	

SPINE LCI dataset: Production of ethyl alcohol using energy forest and the enzyme-method

Administrative	
Finished	Y
Date Completed	1996
Copyright	
Availability	Public

Technical System	
Name	Production of ethyl alcohol using energy forest and the enzyme-method
Functional Unit	1 MJ
Functional Unit Explanation	The amounts in the table show the environmental load per MJ produced ethanol.
Process Type	Gate to gate
Site	
Sector	Fuel
Owner	
Technical system description	Ethyl alcohol can be produced of several kinds of renewable energy sources. The principle in the making of ethyl alcohol is to transform cellulose or farina in the raw material to fermentable sugar. After the fermentative process the water is removed through distillation and the remaining part is ethyl alcohol with high concentration. In the case studied here the producing plant is of the size 20 000 - 25 000 ton per year. This is considered to be a fairly small amount, which probably is not able to keep a plant in operation in economical terms. The raw material used is energy forest (Willow). The preparation consists of drying and grinding of the biomass, to enlarging the contact surface before the hydrolysis. The difference occurs in the hydrolysis. During the hydrolysis the sugar and lignin are separated. These data concern the Enzyme-method. In this method there are enzymes, which are produced by the biomass, that breaks down the cellulose to sugar. After this process the sugar is fermented into ethyl alcohol, which is separated through distillation. For further information Von Sievers & Zacchi, 1993, A techno-economical comparison of three processes for the production of ethanol from wood, Kemisk Apparatteknik, LTH, 1993.

System Boundaries

Nature Boundary	The energy consumption and the emissions to air are accounted for. Also the raw material used is reported in the data.
Time Boundary	The most advanced technology is used in the study
Geographical Boundary	
Other Boundaries	
Allocations	The by-products are sorted in usable and unusable by-products. The unusual by-products are assumed to be useless, and are the energy use and emissions are allocated to the produced ethyl alcohol. The usable by-products carry their own environmental load.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1993
Data Type	Unspecified
Represents	Not relevant.
Method	Literature study of Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5, where the data are taken from Von Sievers & Zacchi, 1993, A techno-economical comparison of three processes for the production of ethanol from wood, Kemisk Apparatteknik, LTH, 1993. No information about the selection of data has been given in the report (Blinge 1996).
Literature Reference	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Notes	Prepared for Ecolab by Annika Olsson. Checked by Malin Bogeskär.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Willow	3.164			MJ	Forestral ground	
	Input	Refined resource	Electricity	0.157			MJ	Technosphere	
	Output	Emission	CO	5.659			mg	Air	
	Output	Emission	CO2	1080			mg	Air	
	Output	Emission	HC	1.517			mg	Air	
	Output	Emission	NOx	20.827			mg	Air	
	Output	Emission	SO2	1.517			mg	Air	
	Output	Emission	Susp solids	0.241			mg	Air	
	Output	Product	Ethanol	1			MJ	Technosphere	
	Output	Product	Lignin	0.685			MJ	Technosphere	

About Inventory

Publication	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5. -- Data documented by: Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Persons or companies intereste

General Purpose	
Detailed Purpose	The data are part of a study concerning alternative fuels
Commissioner	- KFB Komunikations Forsknings Beredningen Box 5706 Linnégatan 2 114 87 Stockholm Sweden.
Practitioner	Blinge Magnus, Arnäs P, Bäckström S, Furnander Å, Hovelius K - Department of Transportation and Logistics Chalmers University of Thechnology.
Reviewer	
Applicability	The data is taken from experimental production, and can therefore not be used with success to evaluate the present situation. Testing plants that need not function economically is not to be equalled to commercially producing plants. Because the environmental load is not proportional to the production amount this data should not be used on plants with much greater or smaller production. Data for the CASH-method and the Enzyme-method are also available in SPINE. Data concerning the raw material energy forest are available in SPINE
About Data	
Notes	

SPINE LCI dataset: Production of extruded aluminium profiles

Administrative	
Finished	Y
Date Completed	2002-05-07
Copyright	EAA
Availability	Public

Technical System	
Name	Production of extruded aluminium profiles
Functional Unit	1000 kg extruded aluminium profile
Functional Unit Explanation	
Process Type	Gate to gate
Site	Not specified. See Geographical boundaries for further information.
Sector	Materials and components
Owner	Not specified. See Geographical boundaries for further information.
Technical system description	The inventory data cover the total semi-fabrication process steps, from extrusion billet production up to packaging before delivery, for the production of aluminium profiles such as those typically used in window or car component manufacture. The internal recycling of process scrap during the extrusion production is included. --- The starting material for the production of rolled aluminium extrusion is an extrusion billet (extrusion ingot). In this documentation the starting material is referred to as ''aluminium ingot'' when it comes from an external primary aluminium or secondary aluminium plant. Rolled aluminium extrusion is also produced by remelting process scrap (Ingot remelting and casting) and this input is referred to as ''casting scrap''. The billet is preheated before extrusion to the required profile. Further processing steps include stretching, sawing and ageing before packaging and shipment to customer. The included process steps are: - Production of semi-finished aluminium - 1. Sawing and scalping 2. Preheating

	3. Extrusion 4. Stretching 5. Sawing 6. Ageing 7. Packaging - Recycling of process scrap - 8. Ingot remelting and casting Production of electricity included in the system. Some further details on the process step Ingot remelting and casting is given below: From the process steps 1 and 3-6, Sawing and scalping , Extrusion, Stretching, Sawing and Ageing scrap is going to the process step Ingot remelting and casting. 268 kg scrap is delivered from Sawing and scalping and 309 kg scrap is delivered from Extrusion, Stretching, Sawing and Ageing. 23 kg casting scrap is recycled within the ingot remelting and casting process.

System Boundaries

Nature Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- Cut-off criteria through out this inventory is basically relevance, as checked by the industry expert team monitoring the work and confirmed by reviewer I. Boustead. As a rough guideline ''less than 1% of total mass'' is applied for the inputs, i.e if the input is less than 1% of the total mass, then it is not included in the inventory table. The base for the choices of included inventory parameters is not further described in the EAA report.
Time Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- The data derived from an industry survey from 1998 and includes literature data from reports dated 1998 and 1999.
Geographical Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- It is not always explicit in the report where the different included process steps take place. Data may be acquired from outside of Europe, e.g. regarding ancillary materials. See litterature references (LitteratureRef) next to the flow table (FlowMetaData) for further information about the data sources for each process step.
Other Boundaries	See Nature boundaries for a specification of the cut-off criteria that has been applied.
Allocations	Allocations are not explicitly specified in the Environmental Profile Report 2000.
Systems Expansions	System expansions are not explicitly specified in the Environmental Profile Report 2000.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Not relevant.
Method	PRODUCTION OF SEMI-FINISHED ALUMINIUM The data derive from an industry survey with a coverage ranging from 20% to 70%, depending on the product in question. INGOT REMELTING AND CASTING (RECYCLING OF PROCESS SCRAP) Data were obtained from aluminium-integrated cast house operations, i.e. cast houses associated with semi-finished aluminium production. The 1998 survey on semi-finished aluminium products also encompassed aluminium-integrated cast houses, with 37% coverage for the recycling of process scrap. TRANSPORTS Transport energy and air emission data have been taken from SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 ELECTRICITY For all manufacturing operations, the consumption of fossil fuels and emissions linked to electricity production was calculated according to the UCTPE 94 electrical energy model as described in BUWAL 250. Emissions from combustion only, i.e. without the precombustion contribution, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of precombustion and combustion in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, inview of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors.
Literature Reference	---Rolled sheet production and process scrap recycling Industry survey from 1998 ---Transport energy, electricity, and air emission - SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems.

Notes	In this inventory profile it is possible to identify which process step (Extruded profile production, Process scrap recycling) the flow is connected to and if it derives from the energy use, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: This substance is connected both to the rextruded profile production and the process scrap recycling.	Input	Natural resource	Brown coal	158			kg	Ground	
Notes: This substance is connected both to the rextruded profile production and the process scrap recycling.	Input	Natural resource	Crude oil	43			kg	Ground	
Notes: This substance is connected both to the rextruded profile production and the process scrap recycling.	Input	Natural resource	Hard coal	151			kg	Ground	
Notes: This substance is connected both to the rextruded profile production and the process scrap recycling.	Input	Natural resource	Natural gas	135			kg	Ground	
Notes: 12,4 kg is alloying additives as master alloys and 6,2 kg in pure form. This substance is connected to the process scrap recycling.	Input	Refined resource	Alloying additives	18.6			kg	Technosphere	
	Input	Refined resource	Aluminium ingot	1013			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Ar-gas	0.53			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Chlorine	0.081			kg	Technosphere	
Notes: Includes electricity produced by nuclear and hydro power plants (nuclear 532 kWh and hydro 217 kWh). This substance is connected both to the extruded profile production and the process scrap recycling.	Input	Refined resource	Electricity	749			kWh	Technosphere	
Notes: Fluxing agents are salts. This substance is connected to the process scrap recycling.	Input	Refined resource	Fluxing agents	0.36			kg	Technosphere	
Notes: This substance is connected to the extruded profile production.	Input	Refined resource	NaOH	28			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Nitrogen	0.3			kg	Technosphere	
Notes: The paper and cardboard is used for packaging. This substance is connected to the extruded profile production.	Input	Refined resource	Paper and cardboard	3			kg	Technosphere	
Notes: The paper and cardboard is used for packaging. This substance is connected to the extruded profile production.	Input	Refined resource	Plastics	2.1			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Refractory materials	1.2			kg	Technosphere	
Notes: Steel is used for packaging. This substance is connected to the extruded profile production.	Input	Refined resource	Steel	0.9			kg	Technosphere	
Notes: Water is used for cooling. This substance is connected both to the extruded profile production and the process scrap recycling.	Input	Refined resource	Water	30			m3	Technosphere	
Notes: Wood is used for packaging. This substance is connected to the extruded profile production.	Input	Refined resource	Wood	28			kg	Technosphere	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	CH4	2.2			kg	Air	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	Chlorides	0.002			kg	Air	
Notes: This emission derives from the process scrap recycling.	Output	Emission	Chlorides	2.7			kg	Water	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	CO	0.23			kg	Air	

Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	CO2	860			kg	Air	
Notes: This emission derives from the rextruded profile production.	Output	Emission	COD	0.003			kg	Water	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	Dust	0.69			kg	Air	
Notes: HC, other than CH4. This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	HC	0.79			kg	Air	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is partly connected to the energy use.	Output	Emission	HCl	0.1			kg	Air	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	HF	0.01			kg	Air	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	NH3	0.0016			kg	Air	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	NOx	1.5			kg	Air	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	Oil/grease	0.063			kg	Water	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	SO2	3.2			kg	Air	
Notes: This emission derives both from the extruded profile production and the process scrap recycling. It is connected to the energy use.	Output	Emission	Suspended particles	0.33			kg	Water	
	Output	Product	Extruded aluminium profile	1000			kg	Technosphere	
Notes: This emission derives from the extruded profile production.	Output	Residue	Hazardous waste	1.6			kg	Technosphere	
Notes: The oil is reprocessed or burnt. This residue derives from the extruded profile production.	Output	Residue	Oil	1.7			kg	Technosphere	
Notes: This residue derives both from the extruded profile production.	Output	Residue	Sludge	29			kg	Technosphere	
Notes: This residue derives both from the extruded profile production and the process scrap recycling.	Output	Residue	Solid waste unspecified	23			kg	Technosphere	

About Inventory

Publication	Environmental Profile Report for the European Aluminium Industry, European Aluminium Association, April 2000 -- Data documented by: Maria Erixon, IMI, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 8 May 2002 --
Intended User	LCA-practitioners.
General Purpose	The European Aluminium Association (EAA) aims to contribute to further environmental improvements in aluminium products in a life cycle concept.
Detailed Purpose	The purpose with the Environmental Profile Report 2000 is to provide LCA-practitioners with detailed and up-to-date information representing the aluminium industry activities in Europe. The purposes with formatting the Environmental Profile Report 2000 for the European

	Aluminium Industry to the data documentation format SPINE, according to the data documentation criteria applied at Centre for environmental assessment of Product and Material systems (CPM) are: - CPM and European Aluminium Association (EAA) are anxious to provide life cycle assessment (LCA) practitioners with accurate and up to date environmental data for aluminium production. - EAA is interested in the SPINE formatting procedure and result, as the format is a base for (and therefor somewhat similar to) the new Technical Specification in ISO, ISO 14048, regarding LCA data documentation format. - EAA is interested in the CPM data quality control and documentation criteria.
Commissioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Practitioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Reviewer	Dr. Ian Boustead, - 2 Black Cottages West Grinstead, Horsham GB-West Sussex RH13 7BD
Applicability	--- SPECIFIC INFORMATION FOR THIS DATA SET --- ENERGY USE IN THE DIFFERENT INCLUDED PROCESS STEPS The energy directly consumed by the operations enclosed within the system bounderies, i.e. in the various production steps, are presented below. See the headline ''DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION'' in About Data for further information. --- Production of semi-finished aluminium --- Fuel oil (kg) 0,65 Gas (kg) 66 Electricity UCTPE* (kWh) 1142 --- Recycling of process scrap --- Gas (kg) 35 Electricity UCTPE* (kWh) 179 * UCTPE 94 is an electrical energy model for energy supporting all processes in this system (including transports), except electrolysis and cast house. It is described in BUWAL 250, see litterature references. ENERGY CONSUMPTION - INFLUENCE OF ALLOY GRADE AND INGOT HOMOGENEISATION TREATMENT This data set represents an average aluminium alloy. Different alloy types have different energy consumption data; some alloys undergo ingot homogeneisation thermal treatment; hard alloys need more energy for rolling than soft alloys or unalloyed aluminium. In the table below you can find some examples of the variation. The values are presented per 1000 kg rolled aluminium sheet. Alloy groups: I. includes unalloyed aluminium (all 1xxx designations) II. includes alloyed aluminium designated 3xxx, 5xxx (Mg<2,5%), 6xxx and 8xxx III. includes alloyed aluminium designated 2xxx, 5xxx (Mg>2,5%) and 7xxx Electricity consumption (kWh) I II III Overall weighted average non-homogenised 592 642 661 622 homogenised 637 687 706 667 Gas consumption (kg) non-homogenised 79,3 79,6 79,5 79,5 homogenised 94,3 94,6 94,5 94,5 --- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- RECOMMENDATIONS BY EAA WHEN USING THE DATA The data provided by the EAA members for their own process steps are the most up-to-date average data available for these processes, and it is recommended that they be used for LCA purposes. Older literature data should be disregarded, as it may no longer be representative due to technological improvements, progress in operating performance, changes with regard to raw materials or waste treatment, etc. To complete the product system inventory, data - on the production of consumer products, from semi-fabricated aluminium, - on the performance of consumer products in the use phase, and - on the recovery of scrap prior to remelting at the end of the product's useful life should be acquired. EAA recommend that these data be used in LCA studies in accordance with methodologies within the framework of the international standards in the ISO 14040-series.

	RELATED DATA SETS IN SPINE DATA FORMAT The data presented in the Environmental Profile Report is reformatted in to the SPINE format and structured according to the SPINE concept in as many separate activities (sub-systems) as possible. The system scope for the study as a whole is primary aluminium production, semi-finished aluminium production, and recycling. The SPINE formatting resulted in 7 activities. These activities are all published in the SPINE@CPM database. The production and recycling step are intended to be used together. For example, to obtain a cradle to gate-system for rolled aluminium sheet, the activity Primary aluminium production should be connected to the activity Production of rolled aluminium sheet. A recycling step (Aluminium recycling by refiners) could also be connected to such a system, depending on the scope. -- List of activities formatted in the SPINE-format, published in SPINE@CPM -- Primary aluminium production 1. Primary aluminium production Semi-finished aluminium product fabrication 2. Production of rolled aluminium sheet 3. Production of extruded aluminium profiles 4. Production of 0,02-0,2 mm single-rolled aluminium foil 5. Production of 0,005-0,02 mm double-rolled aluminium foil Recycling 6. Re-melting of aluminium scrap 7. Aluminium recycling by refiners Please note: The recycling process 6. Re-melting of aluminium scrap is included in the semi-finished aluminium product fabrication, i.e. activities 2-5. When designing a product system with the activities above where recycled aluminium is regarded, the activity Aluminium recycling by refiners should be used. The Re-melting of aluminium activity is only a specification if the user is specifically interested in this process step. RECYCLING RATES FOR ALUMINIUM PRODUCTS AFTER USE After use, aluminium products are a valuable re-usable resource. The European recycling rates for end products are currently around 95% for the automotive sector and 85% for the building sector. IMPROVEMENTS IN THE ENVIRONMENTAL PERFORMANCE OF ALUMINIUM PRODUCTS AND PROCESSES OVER THE PAST FEW YEARS Over the past few years EAA has achieved major improvements in the environmental performance of its production processes by means of the following: - improvement on existing technology - development and introduction of new technology and operations - increased recycling of all materials in the production process. Examples of major environmental improvements in aluminium products achieved over the past few years include: - weight reduction by downgauging in the packaging sector - energy savings through weight reduction and subsequent fuel reduction in the transport sector - reduction of maintenance in the building sector The previous Ecological Profile Report from EAA was published in 1996.
About Data	--- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- PRECISION According to EAA, the environmental data figures in the inventory table are usually accurate to a precision of 5%. DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION The electricity supply systems and fuel production and use (transport energy and emission data) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250' and EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems. All emissions connected with total fuel consumption (i.e. production and combustion of oil, gas or coal) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250', table 16.9. Emissions from combustion only, i.e. excluding the contribution of the production of the fuel, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of production and combustion of fuels in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, in view of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors. REVIEW OUTSPOKE

	Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, April 2000, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. Ian Bousteds' review comments on the Environmental Profile Report for the European Aluminium Industry, April 2000: ''...I have received the detailed calculations on which this present environmental report is based. All of the queries that I raised after working through these reports were answered satisfactory.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Good-quality data were supplied by the EAA member companies, and the number of companies participating provides good coverage of the various processes, meaning that the results can be regarded as representative of the industryas a whole for the production of primary aluminium and subsequent conversion processes.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Because of the very fragmented nature of the recycling industry and wide variations in practices, it is recognised that the data presented for this sector of the industry can only be regarded as indicative. Nevertheless it is helpful to have such information from an authorative source.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000
Notes	REVIEWER Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. See AboutData for review comments.

SPINE LCI dataset: Production of guide rings used for spherical roller bearings

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Production of guide rings used for spherical roller bearings
Functional Unit	One guide ring, 9.604kg
Functional Unit Explanation	One spherical roller bearing 232/530 consists of following components: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 rollers (coated or non-coated) The functional unit for this process is one guide ring. The complete name of the guide ring is: RG-232/530 C/243475, and it weighs 9.604 kg. The data can be used (together with data for the other ingoing components) to calculate environmental impact for a complete spherical roller bearing 232/530. Dimensions of the bearing 232/530: di= 530 mm dy= 980 mm breadth= 355 mm The activities for the production of the other ingoing components are also available at SPINE@CPM: * Production of bearing rings * Production of brass cages used for spherical roller bearings * Production of bearing rollers (á 9.2 kg) and the activity for the production of a complete SRB 232/530 can be found as: * Production of SKF Spherical Roller Bearing 232/530
Process Type	Cradle to gate

Site	SKF Mekan ABBox 89 641 21 Katrineholm
Sector	Materials and components
Owner	SKF Mekan ABBox 89 641 21 Katrineholm
Technical system description	The guide ring RG-232/530 C/243475 is manufactured at SKF Mekan AB in Katrineholm, Sweden. A guide ring is used in a spherical roller bearing and its function is to assure that the rollers stay in the raceways of the bearing. The raw material is recycled iron and steel scrap from their own processes and from SKF in Göteborg, but also pig iron produced in Russia. The production of guide rings is very similar to the production of bearing housings at SKF Mekan AB, and much data for the calculations is obtained from an earlier LCA study of the bearing housing SNL 511-609. The following process steps are included in this dataset: 1. Production of pig iron 2. Smelting of iron, type V10 3. Smelt iron in a ladle 4. Heating of smelt iron in a holding furnace 5. Smelt iron in a teaming ladle before casting 6. Casting of iron, type V10 7. Production of quartz sand 8. Cleaning and blastering of cast iron 9. Turning of cast iron rings 10. Phosphatising of cast iron rings In the main treatment there are many different chemicals added. The mineral oil in all of these chemicals is taken into account and followed from the cradle with the activities: ''Extraction of crude oil'' and ''Refining of crude oil''. Each of the process steps 1-10 are further described in separate activities in the SPINE@CPM database. In the dataset following transports are included: A. Transport of pig iron from Riga to Köping (578 km, freighter 2000 - 8000 dwt) B. Transport of pig iron from Köping to Katrineholm (70 km, truck 40/60, Euro 3) B. Transport of steel scrap from SKF Göteborg to Katrineholm (338 km, truck 40/60, Euro 3) C. Transport of quartz sand from Broby to Katrineholm (40 km, truck 40/60, Euro 3) -- 1. Production of pig iron: Pig iron is produced in Russia and is transported with freighter and truck to SKF Mekan AB in Katrineholm. The raw material is iron ore which is smelted in a blast furnace and rolled into billets. Since no information was available from the Russian producer, this dataset refer to production of pig iron at SSAB in Luleå, Sweden. 2. Smelting of iron, type V10 To produce one guide ring 33,75 kg smelted cast iron is needed. The smelt consists of: Pig iron: 3% Steel scrap: 25% Recycled iron: 58% (from their own processes) Steel scrap 14% (from cage manufacturing at SKF Göteborg) Alloying substances are added to give the material the optimal chemical composition. These substances are: Carbomax PK M 1,30% FeMn 0,10% FeS 0,02% Cu 0,07% SiC 1,10% The raw material and the alloying substances are divided into the right proportions according to a specific prescription and are then smelted in the electric furnaces. For the smelting process data from bearing housing was used, but the ingoing components were changed according to the prescription, type V10, which is used specific for guide rings. 3. Smelt iron in a ladle, 4. Heating of smelt iron in a holding furnace, 5. Smelt iron in a teaming ladle before casting: After the smelting process, the smelt is transported in a ladle to the furnace to keep it heated. The smelt is then transported in a teaming ladle to the casting process. The different ladles are preheated through combustion of LPG before use. 6. Casting of iron, type V10: In the casting process the guide rings are formed into a desired shape. A sand form is used, that in this case is a Novaset sand system. The Novaset sand system consists of a forming mass that is self-stiffened [26]: 15,65 kg sand 0,151 kg Novaset 400 0,044 kg Hardener 4030 When the form is rigid it is treated with isopropanol in order to make the surface tight.

	The smelt is then poured into the form and after the smelt has become hard enough, the formed is cracked. The Novaset sand is transported as non hazardous waste to a deposit. 7. Production of quartz sand: The quartz sand used for the sand form in the casting process, come from a sand pit in Broby, Sweden. Digging machines are used in the sand pit, and these are consuming diesel. The sand is dried to lower the moisture content and in the drying process, fuel oil is used. Both production and combustion of diesel and heavy fuel oil are included in this dataset. 8. Cleaning and blastering of cast iron : When the cast iron have been cooled it is cleaned and blastered. It means that remaining material from the casting process (e.g. sand) is removed. This process is identical for bearing housing and guide rings. The casted iron components are cleaned and blastered to get rid of remaining sand and to treat the surface. 9. Turning of cast iron rings: The first step in the final treatment of the guide ring is turning. In this step the ring is turned to its final shape. Iron scrap is returned as raw material and reused in the smelting process. 10. Phosphatising of cast iron rings: When the ring has been turned into its final shape, it is phosphatised. This is done to protect the surface from corrosion by adding rust inhibitors. First the ring is defatted in a highly alkaline bath. Then it is washed and treated in a bath with phosphoric acid. Finally it is treated in an oil-bath with corrosion protective agents and dried. The rings are packed and transported to SKF in Göteborg by truck. The packaging material and the transport by truck from Katrineholm to Göteborg are NOT included in this study.

System Boundaries

Nature Boundary	Recycled iron and steel scrap are not considered as resources and are not followed from the cradle. The nature boundary is the technosphere. Many of the chemicals used in the process are not followed from the cradle, since it was too time consuming and the impact was assumed to be very small since the total amount and the substances according to product data sheets not were considered hazardous. The mineral oil in the different chemicals is taken into consideration though and is followed from the cradle. The steel scrap from the process is not followed to the grave, since it is reused in the process. The steel scrap is considered to be a co-product ending in the technosphere.
Time Boundary	The data was collected during the autumn 2002 and no changes in the procedure are planned for the nearest future.
Geographical Boundary	All activities except for the production of pig iron take place in Sweden. The production of pig iron takes place in Russia.
Other Boundaries	In the dataset following transports are included: A. Transport of pig iron from Riga to Köping (578 km, freighter 2000 - 8000 dwt) B. Transport of pig iron from Köping to Katrineholm (70 km, truck 40/60, Euro 3) B. Transport of steel scrap from SKF Göteborg to Katrineholm (338 km, truck 40/60, Euro 3) C. Transport of quartz sand from Broby to Katrineholm (40 km, truck 40/60, Euro 3) All transports are included in the system, with diesel production (for truck transports) and heavy fuel oil (for freighter from Riga to Köping).. The Electricity production is included for all activities. Swedish average electricity is used for the processes in Sweden, and European average electricity is used for the pig iron production in Russia..
Allocations	Most of the data is allocated according to weight. See each separate activity.
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	Not relevant.

Method	Data has been gathered from interviews and supplied material from Marja Andersson, SKF Mekan AB, in Katrineholm. She is responsible for environmental questions and much of the data comes from the environmental report from year 2001. SKF Mekan AB has recently published an LCA of Bearing Housing and much data was the same for the guide ring, and could be used directly. See under each separate sub activity for more detailed information.
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	In this inventory profile it is possible to identify which process step (Extruded profile production, Process scrap recycling) the flow is connected to and if it derives from the energy use, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Copper in ore	0.0002806			kg	Ground	
	Input	Natural resource	Iron in ore	0.001385			kg	Ground	
	Input	Natural resource	Lead in ore	4.987e-006			kg	Ground	
	Input	Natural resource	Uranium in ore	0.0005287			kg	Ground	
	Input	Refined resource	Absol	0.01178			kg	Technosphere	
	Input	Refined resource	Al	0.001005			kg	Technosphere	
	Input	Refined resource	Aluminium oxide	0.003068			kg	Technosphere	
	Input	Refined resource	Antifoam SE	1.129e-005			m3	Technosphere	
	Input	Refined resource	Ba	0.001005			kg	Technosphere	
	Input	Refined resource	Bentonite	0.0001945			kg	Ground	
	Input	Refined resource	Biomass	0.1604			kg	Technosphere	
	Input	Refined resource	Biomass	0.354			kg	Ground	
	Input	Refined resource	BL AIR set	0.004804			kg	Technosphere	
	Input	Refined resource	Blast furnace gas	1.187			MJ	Technosphere	
	Input	Refined resource	Bonder 202A	0.006779			kg	Technosphere	
	Input	Refined resource	Bonder 202E	0.02034			kg	Technosphere	
	Input	Refined resource	Briquets (recycled material)	0.04289			kg	Technosphere	
	Input	Refined resource	Ca	0.001005			kg	Technosphere	
	Input	Refined resource	Carbon	0.4387			kg	Technosphere	
	Input	Refined resource	Coke dust	3.342			kg	Technosphere	
	Input	Refined resource	Coke gas	0.5931			MJ	Technosphere	
	Input	Refined resource	Crude oil	0.7972			MJ	Technosphere	
	Input	Refined resource	Crude oil	2.046			kg	Ground	
	Input	Refined resource	Cu	0.02356			kg	Technosphere	
	Input	Refined resource	Dimatrenn SL	9.014e-008			m3	Technosphere	
	Input	Refined resource	Drivibe 400 Z	0.0273			kg	Technosphere	
	Input	Refined resource	Fe-pellets	1.375			kg	Technosphere	
	Input	Refined resource	Ferric oxide	0.0002561			kg	Technosphere	
	Input	Refined resource	Ferromanganese	0.03375			kg	Technosphere	

	Input	Refined resource	FeS	0.006658			kg	Technosphere	
	Input	Refined resource	Gardorol CP 8010	4.744e-005			m3	Technosphere	
	Input	Refined resource	Grease	0.0001055			kg	Technosphere	
	Input	Refined resource	H2O	0.01229			kg	Ground	
	Input	Refined resource	H2O	0.05326			m3	Technosphere	
	Input	Refined resource	H2O	6.793			kg	Water	
	Input	Refined resource	Hard coal	0.5588			kg	Ground	
	Input	Refined resource	HCl	0.004068			kg	Technosphere	
	Input	Refined resource	Heat	3.51			MJ	Technosphere	
	Input	Refined resource	Hg	8.194e-008			kg	Technosphere	
	Input	Refined resource	Hydro power	69.37			MJ	Ground	
	Input	Refined resource	Hyspin AWS 46	2.1e-005			m3	Technosphere	
	Input	Refined resource	Isofrax	2.827e-006			m2	Technosphere	
	Input	Refined resource	Kermag EN 95	2.883e-005			kg	Technosphere	
	Input	Refined resource	LD-slag	0.03688			kg	Technosphere	
	Input	Refined resource	Lignite	0.02971			kg	Ground	
	Input	Refined resource	Lime	0.001875			kg	Technosphere	
	Input	Refined resource	Limestone	0.05779			kg	Ground	
	Input	Refined resource	Magna BD 68	0.0004219			m3	Technosphere	
	Input	Refined resource	Methanol	0.0232			kg	Technosphere	
	Input	Refined resource	Municipal water	8.34e-005			m3	Technosphere	
	Input	Refined resource	Natural gas	0.1042			kg	Ground	
	Input	Refined resource	Oxygen	0.02195			kg	Technosphere	
	Input	Refined resource	Oxygen	3.49e-011			m3	Technosphere	
	Input	Refined resource	Peat	0.04849			kg	Technosphere	
	Input	Refined resource	Phenol	0.01237			kg	Technosphere	
	Input	Refined resource	Plaster	0.01024			kg	Technosphere	
	Input	Refined resource	Potassium Hydroxide	0.116			kg	Technosphere	
	Input	Refined resource	Potassium oxide	0.0006811			kg	Technosphere	
	Input	Refined resource	Propene	0.01229			kg	Technosphere	
	Input	Refined resource	R03	1.055e-007			m3	Technosphere	
	Input	Refined resource	Recycled iron	28.01			kg	Technosphere	
	Input	Refined resource	Rimitanol TFA17	6.779e-006			m3	Technosphere	
	Input	Refined resource	Si	0.06294			kg	Technosphere	
	Input	Refined resource	SiC	0.3713			kg	Technosphere	
	Input	Refined resource	Silicon dioxide	0.0128			kg	Technosphere	
	Input	Refined resource	Slag	0.004981			kg	Technosphere	

	Input	Refined resource	Sodium hydroxide	0.003559			kg	Technosphere	
	Input	Refined resource	Sodium oxide	0.0006811			kg	Technosphere	
	Input	Refined resource	Steam	0.01795			MJ	Technosphere	
	Input	Refined resource	Steel	0.1083			kg	Technosphere	
	Input	Refined resource	Sulphur	0.002218			kg	Technosphere	
	Input	Refined resource	Sulphuric acid	0.00314			kg	Technosphere	
	Input	Refined resource	SW 8571	1.055e-006			m3	Technosphere	
	Input	Refined resource	Technical white	6.328e-006			m3	Technosphere	
	Input	Refined resource	Thermal energy	0.3156			MJ	Technosphere	
	Input	Refined resource	Triacetin	0.2253			kg	Technosphere	
	Input	Refined resource	Trietanolamin	5.56e-005			m3	Technosphere	
	Input	Refined resource	Wind power	0.1459			MJ	Ground	
	Input	Refined resource	Wood	0.0003517			kg	Ground	
	Input	Refined resource	Ytex 1610	0.04293			kg	Technosphere	
	Output	Co-product	Iron scrap	24.15			kg	Technosphere	
	Output	Emission	Acetylene	5.38e-007			kg	Air	
	Output	Emission	Aerosols	0.0009197			kg	Air	
	Output	Emission	Al	1.122e-005			kg	Water	
	Output	Emission	Alkanes	1.906e-005			kg	Air	
	Output	Emission	Alkenes	1.453e-006			kg	Air	
	Output	Emission	Aromates (C9-C10)	4.411e-006			kg	Air	
	Output	Emission	Aromatics	9.58e-008			kg	Water	
	Output	Emission	As	1.443e-007			kg	Water	
	Output	Emission	As	4.588e-007			kg	Air	
	Output	Emission	Benzene	2.577e-005			kg	Air	
	Output	Emission	Benzo(a)pyrene	8.549e-010			kg	Air	
	Output	Emission	BOD	1.785e-007			kg	Water	
	Output	Emission	BOD5	1.626e-006			kg	Water	
	Output	Emission	BOD-7	2.539e-006			kg	Water	
	Output	Emission	Butane	6.092e-007			kg	Air	
	Output	Emission	Ca	2.28e-006			kg	Air	
	Output	Emission	Cd	1.216e-006			kg	Air	
	Output	Emission	Cd	7.547e-008			kg	Water	
	Output	Emission	Cl-	0.03448			kg	Water	
	Output	Emission	CN-	2.487e-007			kg	Air	
	Output	Emission	CN-	8.618e-008			kg	Water	
	Output	Emission	CO	0.01042			kg	Air	
	Output	Emission	CO	1.043e-006			kg	Air	
	Output	Emission	Co	2.196e-008			kg	Water	
	Output	Emission	CO2	6.842			kg	Air	
	Output	Emission	COD	7.91e-005			kg	Water	
	Output	Emission	Cr	2.711e-007			kg	Water	
	Output	Emission	Cr	5.287e-006			kg	Air	
	Output	Emission	Cr3+	4.399e-007			kg	Air	
	Output	Emission	Cr3+	7.811e-007			kg	Water	
	Output	Emission	Cu	3.058e-005			kg	Air	
	Output	Emission	Cu	9.868e-008			kg	Water	
	Output	Emission	Cyanide	4.81e-009			kg	Water	
	Output	Emission	Dioxin	5.053e-012			kg	Air	
	Output	Emission	Dissolved solids	0.0002334			kg	Water	
	Output	Emission	Ethane	1.556e-006			kg	Air	
	Output	Emission	Ethene	3.173e-006			kg	Air	
	Output	Emission	F-	1.079e-005			kg	Water	
	Output	Emission	Fe	5.13e-006			kg	Air	

	Output	Emission	Formaldehyde	1.302e-005			kg	Air	
	Output	Emission	H2S	2.535e-007			kg	Air	
	Output	Emission	H2S	2.822e-009			kg	Water	
	Output	Emission	HC	0.0001409			kg	Air	
	Output	Emission	HCl	0.0001054			kg	Air	
	Output	Emission	HF	1.769e-005			kg	Air	
	Output	Emission	Hg	1.431e-008			kg	Air	
	Output	Emission	Hg	9.6e-012			kg	Water	
	Output	Emission	Hydrocarbons	8.381e-005			kg	Air	
	Output	Emission	Methane	0.008325			kg	Air	
	Output	Emission	Mo	4.56e-007			kg	Air	
	Output	Emission	N total	0.0002006			kg	Water	
	Output	Emission	N2O	6.811e-005			kg	Air	
	Output	Emission	Na	2.137e-005			kg	Air	
	Output	Emission	NH3	5.148e-007			kg	Air	
	Output	Emission	NH3	9.447e-009			kg	Water	
	Output	Emission	NH4+ as N	4.372e-006			kg	Water	
	Output	Emission	Ni	2.409e-005			kg	Air	
	Output	Emission	Ni	4.447e-007			kg	Water	
	Output	Emission	NMVOC	0.003442			kg	Air	
	Output	Emission	NMVOC, diesel engines	0.001653			kg	Air	
	Output	Emission	NMVOC, natural gas combustion	1.129e-005			kg	Air	
	Output	Emission	NMVOC, oil combustion	0.007268			kg	Air	
	Output	Emission	NMVOC, petrol engines	3.076e-016			kg	Air	
	Output	Emission	NMVOC, power plants	8.709e-007			kg	Air	
	Output	Emission	NOx	0.03111			kg	Air	
	Output	Emission	N-tot	3.263e-006			kg	Water	
	Output	Emission	Oil	0.001214			kg	Water	
	Output	Emission	Other organics	0.0009216			kg	Water	
	Output	Emission	PAH	1.426e-008			kg	Air	
	Output	Emission	Particles	0.0121			kg	Air	
	Output	Emission	Particulates	6.638e-006			kg	Air	
	Output	Emission	Pb	5.012e-005			kg	Air	
	Output	Emission	Pb	5.411e-007			kg	Water	
	Output	Emission	Pentane	1.045e-006			kg	Air	
	Output	Emission	Phenol	9.58e-009			kg	Water	
	Output	Emission	PO43-	3.376e-006			kg	Water	
	Output	Emission	Propane	2.17e-006			kg	Air	
	Output	Emission	Propene	5.983e-007			kg	Air	
	Output	Emission	P-tot	5.287e-008			kg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	3.762e+007			Bq	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	4.006e+009			Bq	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Rn-222	1.966e+006			Bq	Air	
	Output	Emission	Sb	3.086e-010			kg	Water	
	Output	Emission	Sb	4.596e-008			kg	Air	
	Output	Emission	Se	3.784e-007			kg	Air	
	Output	Emission	Sn	2.678e-005			kg	Water	
	Output	Emission	SO2	0.01619			kg	Air	
	Output	Emission	SO42-	0.001409			kg	Water	
	Output	Emission	Sr	1.641e-007			kg	Water	
	Output	Emission	Susp solids	2.875e-006			kg	Water	
	Output	Emission	Suspended solids	5.368e-007			kg	Water	

	Output	Emission	Toluene	1.184e-006			kg	Air	
	Output	Emission	V	7.441e-005			kg	Air	
	Output	Emission	V	7.9e-008			kg	Water	
	Output	Emission	VOC	0.02555			kg	Air	
	Output	Emission	VOC, coal combustion	4.849e-008			kg	Air	
	Output	Emission	VOC, diesel engines	1.14e-006			kg	Air	
	Output	Emission	VOC, natural gas combustion	3.221e-015			kg	Air	
	Output	Emission	Xylene	9.578e-008			kg	Air	
	Output	Emission	Zn	0.0002176			kg	Air	
	Output	Emission	Zn	4.07e-007			kg	Water	
	Output	Product	Guide ring	9.604			kg	Technosphere	
	Output	Residue	As	4.23e-006			kg	Technosphere	
	Output	Residue	Ashes	0.002413			kg	Technosphere	
	Output	Residue	Bulky	0.01773			kg	Technosphere	
	Output	Residue	Cd	1.224e-005			kg	Technosphere	
	Output	Residue	Co	3.682e-006			kg	Technosphere	
	Output	Residue	Cr	2.684e-005			kg	Technosphere	
	Output	Residue	Cu	7.477e-005			kg	Technosphere	
	Output	Residue	Demolition	0.001311			kg	Technosphere	
	Output	Residue	Disposal waste	0.00894			kg	Technosphere	
	Output	Residue	Disposal waste	0.02888			kg	Ground	
	Output	Residue	Emulsion	0.382			kg	Technosphere	
	Output	Residue	glugol	0.0009372			kg	Technosphere	
	Output	Residue	Grease	0.001847			kg	Technosphere	
	Output	Residue	Hazardous	0.008545			kg	Technosphere	
	Output	Residue	Highly radioactive	0.0008664			kg	Technosphere	
	Output	Residue	Industrial	0.1887			kg	Technosphere	
	Output	Residue	krymp och sträckfilm	0.001383			kg	Technosphere	
	Output	Residue	Mn	0.0008194			kg	Technosphere	
	Output	Residue	Ni	1.454e-005			kg	Technosphere	
	Output	Residue	Oil	0.03117			kg	Technosphere	
	Output	Residue	Oil Emulsion	0.0008305			kg	Technosphere	
	Output	Residue	Other	2.071			kg	Technosphere	
	Output	Residue	Other paper	0.01073			kg	Technosphere	
	Output	Residue	Paper	0.005113			kg	Technosphere	
	Output	Residue	Particles	3.768			kg	Technosphere	
	Output	Residue	Pb	0.0006248			kg	Technosphere	
	Output	Residue	Radioactive	4.405e-006			kg	Technosphere	
	Output	Residue	Slag	0.5141			kg	Technosphere	
	Output	Residue	Slags & ashes (energy production)	9.578e-005			kg	Technosphere	
	Output	Residue	Sludge	0.0207			kg	Technosphere	
	Output	Residue	Solid	80.92			kg	Technosphere	
	Output	Residue	solvent	0.0005006			kg	Technosphere	
	Output	Residue	Sulphur	0.0006197			kg	Technosphere	
	Output	Residue	Waste Incinerated	0.04537			kg	Technosphere	
	Output	Residue	Zn	0.0023			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.

Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases. The detailed purpose in the study from where much of the data is obtained, was to calculate the environmental impact from production of a bearing housing.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for casted iron products with the same amount of ingoing components (prescription V10) and with the same production process and process equipment as in this study. The data is site specific for SKF Mekan AB in Katrineholm, since the transports from the suppliers are included. The data can be used (together with data for the other ingoing components) to calculate environmental impact for a complete SKF spherical roller bearing 232/530. The activities for the production of the other ingoing components are also available at SPINE@CPM: * Production of bearing rings * Production of brass cages used for spherical roller bearings * Production of bearing rollers (á 9.2 kg) and the activity for the production of a complete SRB 232/530 can be found as: * Production of SKF Spherical Roller Bearing 232/530
About Data	Data is gathered from interviews with Marja Andersson, SKF Mekan AB, Katrineholm. The production of guide rings is very similar to the production of bearing housings at SKF Mekan AB, and much data for the calculations is obtained from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002. See each separate activity.
Notes	

SPINE LCI dataset: Production of Hardener 2542 for melamine urea formaldehyde resins 1241 and 1242 production

Administrative	
Finished	Y
Date Completed	2003-03-26
Copyright	Casco Products
Availability	

Technical System	
Name	Production of Hardener 2542 for melamine urea formaldehyde resins 1241 and 1242 production
Functional Unit	1 kg hardener 2542
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg hardener 2545. The hardener is delivered with 70% active substance
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Hardener 2542 is a mixture of resorcinol, kaolin, formic acid, thickener and water. Mixing of the raw materials takes place in Akzo Nobel Decorative Coatings plant in Kristinehamn. The hardener is delivered in tank trucks, disposable containers (polyethylene/steel), Fluid bags (polyethylene), Plastic jerrycans (polytethylene) Return containers or Steel drums.

	Packages are not included in the study. The production of the main raw materials is described below: 1. Oil production: The study includes winning, delivery to shore and storage. Oil is used in the production of resorcinol via benzene or propene 2. Resorcinol is deliverd by two different supplier. One uses propen and oxygen in the Hock process. An american manufacturer uses the sulphonation process to produce resorcinol form benzene, oleum , sodium hydroxide and trona. 3. Kaolin is extracted from the earth. Extraction and transports are accounted for. 4. Formic acid is produced from Sulphuric Acid and Sodium formate. Cradle to gate data from the supplier were used. 5. A cellulose derivative is used as thickener. Data for the actual thickener were not available but could be replaced by cradle ot gate data for a similar one. 6. The raw materials, additives and water are mixed at ambient temperatures. Overall information: Transports are included in the system.

System Boundaries

Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally, in dense populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1998, beeing yearly averages where possible. No great changes after that are estimated. The data from Decorative Coatings factory in Kristinehamn are from 1999.
Geographical Boundary	The production of the raw materials for resorcinol is made in Japan and the US and the other raw materials on different sites in Europe. The production of Hardener 2542 is made at Decorativ Coatings' factory, Kristinehamn, Sweden.
Other Boundaries	Packages are not included in this study. The transportation to the users, use and final desposal of the hardener is not included. The environmental effects associated with the manufacture of capital equipment and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included. The Japanese resorcinol manufacurer missed data emission and waste data . The american manufacturer seemed to have overestimated raw material use (including emissions and waste resulting form raw materials)
Allocations	Emissions and waste at the Akzo Nobel Decoraitve Coatings plant in Kristinehamn where the hardener is produced are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1999
Data Type	Derived, unspecified
Represents	Not relevant.
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from environmental report 1999 and Producktion Statistics 1999. Allocations were made on mass basis. For further information see About data.
Literature Reference	For further information see About data.
Notes	In this inventory profile it is possible to identify which process step (Extruded profile production, Process scrap recycling) the flow is connected to and if it derives from the energy use, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	983.73			g	Ground	

	Input	Natural resource	Bauxite	0.29			g	Ground	
	Input	Natural resource	Bio fuel	0.62			MJ	Ground	
	Input	Natural resource	Cellulose	11.21			g	Ground	
	Input	Natural resource	Coal	3.55			MJ	Ground	
	Input	Natural resource	Copper ore	1.57			g	Ground	
	Input	Natural resource	Crude oil	22.25			MJ	Ground	
	Input	Natural resource	Heavy oil	0.18			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	2.79			MJ	Ground	
	Input	Natural resource	Iron in ore	0.21			g	Ground	
	Input	Natural resource	Iron ore	24.1			g	Ground	
	Input	Natural resource	Kaolin	298.4			g	Ground	
	Input	Natural resource	Limestone	0.78			g	Ground	
	Input	Natural resource	Methane	0.22			g	Ground	
	Input	Natural resource	NaCl	229.6			g	Ground	
	Input	Natural resource	Natural gas	28.95			MJ	Ground	
	Input	Natural resource	Nitrogen	8.4			g	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	3.88			MJ	Ground	
	Input	Natural resource	Other fuel	1.63			MJ	Ground	
	Input	Natural resource	Recovered energy	-1.02			MJ	Ground	
	Input	Natural resource	Rock salt	6.25			g	Ground	
	Input	Natural resource	S	90.07			kg	Ground	
	Input	Natural resource	Trona	0.3			kg	Ground	
	Input	Natural resource	Uranium ore	1.27			kg	Ground	
	Input	Natural resource	Wood	0.22			MJ	Ground	
	Output	Emission	AOX	21			mg	Water	
	Output	Emission	Aromatics	0.019			g	Air	
	Output	Emission	BOD	18			mg	Water	
	Output	Emission	Cl-	3.534			g	Water	
	Output	Emission	CO	3.028			g	Air	
	Output	Emission	CO2	1351			g	Air	
	Output	Emission	COD	1.729			g	Water	
	Output	Emission	Dissolved solids	6.49			g	Water	
	Output	Emission	Dust	1.415			g	Air	
	Output	Emission	Gypsum	0.07			g	Water	
	Output	Emission	H+	0.026			g	Water	
	Output	Emission	HCOOH	0.444			kg	Air	
	Output	Emission	Hg	0.005			g	Water	
	Output	Emission	Hydrocarbons	4.646			g	Air	
	Output	Emission	Hydrocarbons	58			mg	Water	
	Output	Emission	Metals	0.118			g	Water	

	Output	Emission	Methane	2.525			g	Air	
	Output	Emission	Methanol	2.403			g	Air	
	Output	Emission	N total	9			mg	Water	
	Output	Emission	N2O	0.023			g	Air	
	Output	Emission	Na+	0.492			g	Water	
	Output	Emission	NaCl	0.558			g	Water	
	Output	Emission	NOx	9.055			g	Air	
	Output	Emission	Oil and fat	0.028			g	Water	
	Output	Emission	PAH	0.016			g	Air	
	Output	Emission	Particles	0.013			g	Air	
	Output	Emission	SO2	3.285			g	Air	
	Output	Emission	SO42-	2.368			g	Water	
	Output	Emission	SOx	4.246			g	Air	
	Output	Emission	Suspended solids	3.307			g	Water	
	Output	Emission	Total organic carbon	0.286			g	Water	
	Output	Emission	VOC	0.565			g	Air	
Notes: Hardener 2542 is to be used with Wood Adhesives 1241 or 1242	Output	Product	Hardener 2542	1			kg	Technosphere	
	Output	Waste	Anything	0			kg	Technosphere	
	Output	Waste	Building waste	0.26			g	Technosphere	
	Output	Waste	Hazardous waste	13.37			g	Technosphere	
	Output	Waste	Highly radioactive waste	0.03			g	Technosphere	
	Output	Waste	Landfill	33.53			g	Technosphere	
	Output	Waste	Mineral waste	2.66			g	Technosphere	
	Output	Waste	Mixed industrial waste	0.92			g	Technosphere	
	Output	Waste	Non hazardous waste	145.89			g	Technosphere	
	Output	Waste	Slags and ash	1.4			g	Technosphere	
	Output	Waste	Sludge	3.1			m3	Technosphere	
	Output	Waste	Sludge (dry matter)	1.52			g	Technosphere	
	Output	Waste	Waste to incineration	0.18			g	Technosphere	
	Output	Waste	Waste to recycling	3.92			g	Technosphere	

About Inventory

Publication	Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Karolina Flemström, IMI- Industrial environmental informatics, Chalmers University of Technology, Sweden Published in SPINE@CPM: 2003-05-28
Intended User	Users of Melamine-Urea-Formald
General Purpose	
Detailed Purpose	To provide LCI data to producers of load bearing rniture and other wood products where Melamine-Urea-Formaldehyde adhesives 1241 or 1242 with hardener 2542 are used.
Commissioner	- Europe.
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	Hardener 2542 is used with MUF 1241 or 1242 for the production of load -bearing timber structures and finger joints. It is widely used in the European gluelam industry. The two adhesives mentioned above can be found in the database. More information about adhesives and hardeners can be given by Casco Products, phone no 46 8 743 4000.
About Data	For the production of hardener 2542 all data originates from Akzo Nobel Decorative Coatings plant in Kristinehamn. For raw materials and auxilary materials suppliers have participated on terms that their data will be treated confidentially. Cradle -to -gate data. were provided for all the raw materianls. Data for the thickener were replaced by data for a similar product. Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity

	data are based on the electricity profiles for each country. For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1997 from ''Annual Energy Review 1999'' (European comission) Building of the power plant is not included.
Notes	

SPINE LCI dataset: Production of Hardener 2545 for urea formaldehyde resins

Administrative	
Finished	Y
Date Completed	2000-03-10
Copyright	Casco Products
Availability	Public

Technical System	
Name	Production of Hardener 2545 for urea formaldehyde resins
Functional Unit	1 kg dry hardener 2545
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg dry hardener 2545. The hardener is delivered with 70% dry content. As an average 20.4 g package material per kg dry hardener is delivered.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Hardener 2545 is a mixture of urea, kaolin, inorganic salts, thickener, water and auxilary materials.The hardener is produced by Casco Products, Sweden. It is delivered in tank trucks, disposable containers (polyethylene/steel), Fluid bags (polyethylene), Plastic jerrycans (polytethylene) Return containers or Steel drums. The production of the main raw materials is described below: 1. Natural gas production: The study includes winning, delivery to shore and storage. Natural gas is used in the production of ammonia. 2. Ammonia and urea production: Ammonia is produced from natural gas, air and water in a steam reforming process. In the process carbon dioxide is produced. The urea plant is situated on the same site as the ammonia plant. Urea is produced by reacting ammonia and carbon dioxide at 150 bar at an operation temparature of 185-190°C. The carbon dioxide used in the urea process comes from the ammonia process. Excess carbon dioxide is accounted for as emission to air. 3. Kaolin is extracted from the earth. Extraction an transports are accounted for. 4. Ammonium Chloride is produced by the Solvay process. 5. The raw materials, additives and water are mixed together at Casco Products Decorative Coatings' factory in Kristinehamn, Sweden. Overall information: Transports are included in the system.

System Boundaries	
Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally , in densly populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.

Time Boundary	Most of the process data for the raw materials are valid for 1997, beeing yearly averages where possible. No great changes after that are estimated. The data from Decorative Coatings factory in Kristinehamn are from 1998.
Geographical Boundary	The production of the raw materials natural gas, ammonia, is made on different sites in Europe. The production of Hardener 2545 is made at Decorativ Coatings' factory, Kristinehamn, Sweden.
Other Boundaries	An average of the packages for the product is included in this study. The transportation to the users, use and final desposal of the hardener is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included. For ammonium chloride emissoins from the Solvey plant were not included.
Allocations	Emissions and waste at the Decoraitve Coatings facory in Kristinehamn where the hardener is produced are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Not relevant.
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from environmental report 1998 and Producktion Statistics 1998. Allocations were made on mass basis.
Literature Reference	
Notes	In this inventory profile it is possible to identify which process step (Extruded profile production, Process scrap recycling) the flow is connected to and if it derives from the energy use, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Bauxite	2			g	Ground	
	Input	Natural resource	Cellulose	7.6			g	Ground	
	Input	Natural resource	Coal	1.23			MJ	Ground	
	Input	Natural resource	Crude oil	3.65			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	0.563			MJ	Ground	
	Input	Natural resource	Iron ore	24.1			g	Ground	
	Input	Natural resource	Minerals	527			g	Ground	
	Input	Natural resource	Natural gas	13.64			MJ	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	1.71			MJ	Ground	
	Input	Natural resource	Other fuel	0.89			MJ	Ground	
	Input	Natural resource	Rock salt	45			g	Ground	
	Input	Natural resource	Scrap	7.7			g	Ground	
	Input	Natural resource	Wood	0.5			MJ	Ground	
	Output	Emission	CO	0.48			g	Air	

	Output	Emission	CO2	762			g	Air	
	Output	Emission	COD	1.1			g	Water	
	Output	Emission	Dissolved solids	0.75			g	Water	
	Output	Emission	Dust	0.8			g	Air	
	Output	Emission	Ethene	0.09			g	Air	
	Output	Emission	H+	0.02			g	Water	
	Output	Emission	HCl	0.009			g	Air	
	Output	Emission	Hg	0.004			g	Water	
	Output	Emission	Hydrocarbons	3.9			g	Air	
	Output	Emission	Methane	6.3			g	Air	
	Output	Emission	N total	0.27			g	Water	
	Output	Emission	Na+	0.53			g	Water	
	Output	Emission	NH3	0.002			g	Water	
	Output	Emission	NH3	0.16			g	Air	
	Output	Emission	NOx	4.4			g	Air	
	Output	Emission	PAH	0.08			g	Air	
	Output	Emission	SO42-	0.1			g	Water	
	Output	Emission	SOx	4.1			g	Air	
	Output	Emission	Suspended solids	2.4			g	Water	
	Output	Emission	Total organic carbon	0.33			g	Water	
	Output	Product	Hardener 2545	1			kg	Technosphere	
	Output	Residue	Hazardous waste	8.1			g	Technosphere	
	Output	Residue	Mineral waste	6.6			g	Technosphere	
	Output	Residue	Mixed industrial waste	1.2			g	Technosphere	
	Output	Residue	Non hazardous waste	355.3			g	Technosphere	
	Output	Residue	Slags and ash	0.29			g	Technosphere	
	Output	Residue	Sludge (Dry matter)	1			g	Technosphere	

About Inventory	
Publication	-- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden Published in SPINE@CPM: 7 August 2001 --
Intended User	Users of urea formaldehyde woo
General Purpose	
Detailed Purpose	To provide LCI data to producers of flooring, carpentry, furniture and other wood products where urea formaldehyde wood adhesives with hardener 2545 are used.
Commissioner	- Casco Products Box 11538, S-10061 Stockholm, Sweden .
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	Hardener 2545 is used with urea formaldehyde wood adhesives like Cascorit 1206, 1205, 1202 and 1274. It is widely used in the European wood working industry for example for furniture, veneering and so on. It is cured in hot- or high frequency presses. The Wood adhesives mentioned above can be found in the database. Data describing Casco Products hardener 2580 is also available in the database. More information about adhesives and hardeners can be given by Casco Products, phone no 46 8 743 4000.
About Data	For the production of hardener 2545 all data originates from Decorative factory in Kristinehamn. For raw materials and auxilary materials suppliers have participated on terms that their data will be treated confidentially. For urea gate-to gate data wer provided, for kaolinand additives cradle -to -gate data. For ammonia and fuel data from APME Ecoprofiles are used. For ammonium chloride no supplier data wer availible. Instead litterature data (Ullman, p.256) were used. Raw materials used are mentioned under ''Object of study/Functions) Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data

	from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1995 from ''Annual Energy Review 1997'' (European comission) Building of the power plant is not included.
Notes	

SPINE LCI dataset: Production of Hardener 2580 for urea formaldehyde resins

Administrative	
Finished	Y
Date Completed	2000-03-10
Copyright	Casco Products
Availability	Public

Technical System	
Name	Production of Hardener 2580 for urea formaldehyde resins
Functional Unit	1 kg dry hardener 2580
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg dry hardener 2580. The hardener is delivered with 70% dry content. As an average 25.3 g of package material per kg dry hardener is delivered.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Hardener 2580 is a mixture of urea, kaolin, inorganic salts, thickener, water and auxilary materials. The hardener is produced by Casco Products, Sweden It is delivered in tank trucks, disposable containers (polyethylene/steel), Fluid bags (polyethylene), Plastic jerrycans (polytethylene) Return containers or Steel drums. The production of the main raw materials is described below: 1. Natural gas production: The study includes winning, delivery to shore and storage. Natural gas is used in the production of ammonia. 2. Ammonia and urea production: Ammonia is produced from natural gas, air and water in a steam reforming process. In the process carbon dioxide is produced. The urea plant is situated on the same site as the ammonia plant. Urea is produced by reacting ammonia and carbon dioxide at 150 bar at an operation temparature of 185-190°C. The carbon dioxide used in the urea process comes from the ammonia process. Excess carbon dioxide is accounted for as emission to air. 3. Kaolin is extracted from the earth. Extraction and transports are accounted for. 4. Ammonium Chloride is produced by the Solvay process. 5. Details of the aluminium sulphate process at the supplier are not known. Cradle to gate data was provided by the supplier. 6. The raw materials, additives and water are mixed together at Casco Products Decorative Coatings' factory in Kristinehamn, Sweden. Overall information: Transports are included in the system.

System Boundaries

Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally , in densly populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1997, beeing yearly averages where possible. No great changes after that are estimated. The data from Decorative Coatings factory in Kristinehamn are from 1998.
Geographical Boundary	The production of the raw materials natural gas, ammonia, is made on different sites in Europe. The production of Hardener 2580 is made at Decorativ Coatings' factory, Kristinehamn, Sweden.
Other Boundaries	An average of the packages for the product is included in this study. The transportation to the users, use and final desposal of the hardener is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included. For ammonium chloride emissons from the Solvey plant were not included.
Allocations	Emissions and waste at the Decoraitve Coatings facory in Kristinehamn where the hardener is produced are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Not relevant.
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from Environmental Report 1998 and Production Statistics 1998. Allocations were made on mass basis.
Literature Reference	
Notes	In this inventory profile it is possible to identify which process step (Extruded profile production, Process scrap recycling) the flow is connected to and if it derives from the energy use, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Bauxite	23			g	Ground	
	Input	Natural resource	Cellulose	5.6			g	Ground	
	Input	Natural resource	Coal	1.26			MJ	Ground	
	Input	Natural resource	Crude oil	4.52			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	0.563			MJ	Ground	
	Input	Natural resource	Iron ore	33.6			g	Ground	
	Input	Natural resource	Minerals	505			g	Ground	
	Input	Natural resource	Natural gas	15.21			MJ	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	1.71			MJ	Ground	
	Input	Natural resource	Other fuel	0.94			MJ	Ground	
	Input	Natural resource	Rock salt	39.3			g	Ground	

	Input	Natural resource	Scrap	11.2			g	Ground	
	Input	Natural resource	Wood	0.42			MJ	Ground	
	Output	Emission	CO	0.5			g	Air	
	Output	Emission	CO2	783			g	Air	
	Output	Emission	COD	1.3			g	Water	
	Output	Emission	Dissolved solids	0.68			g	Water	
	Output	Emission	Dust	1.2			g	Air	
	Output	Emission	Ethene	0.08			g	Air	
	Output	Emission	H+	0.02			g	Water	
	Output	Emission	HCl	0.14			g	Air	
	Output	Emission	Hg	0.004			g	Water	
	Output	Emission	Hydrocarbons	3.6			g	Air	
	Output	Emission	Methane	6.2			g	Air	
	Output	Emission	N total	0.28			g	Water	
	Output	Emission	Na+	0.47			g	Water	
	Output	Emission	NH3	0.002			g	Water	
	Output	Emission	NH3	0.16			g	Air	
	Output	Emission	NOx	4.6			g	Air	
	Output	Emission	PAH	0.08			g	Air	
	Output	Emission	SO42-	0.1			g	Water	
	Output	Emission	SOx	4.3			g	Air	
	Output	Emission	Suspended solids	2.3			g	Water	
	Output	Emission	Total organic carbon	0.31			g	Water	
	Output	Product	Hardener 2580	1			kg	Technosphere	
	Output	Residue	Hazardous waste	8.1			g	Technosphere	
	Output	Residue	Mineral waste	6.3			g	Technosphere	
	Output	Residue	Mixed industrial waste	1.3			g	Technosphere	
	Output	Residue	Non hazardous waste	332.8			g	Technosphere	
	Output	Residue	Slags and ash	0.31			g	Technosphere	
	Output	Residue	Sludge (Dry matter)	1			g	Technosphere	

About Inventory

Publication	-- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden Published in SPINE@CPM: 7 August 2001 --
Intended User	Users of urea formaldehyde woo
General Purpose	
Detailed Purpose	To provide LCI data to producers of flooring, carpentry, furniture and other wood products where urea formaldehyde wood adhesives with hardener 2580 are used.
Commissioner	- Casco Products Box 11538, S-10061 Stockholm, Sweden .
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	Hardener 2580 is used with urea formaldehyde wood adhesives like Cascorit 1206, 1205, 1202 and 1274. It is widely used in the European wood working industry for example for furniture, veneering and so on. It is cured in hot- or high frequency presses. The wood adhesives mentioned above can also be found in the database. Data describing Casco Products hardener 2545 is also available in the database. More information about adhesives and hardeners can be given by Casco Products, phone no 46 8 743 4000.
About Data	For the production of hardener 2580 all data originates from Decorative factory in Kristinehamn. For raw materials and auxilary materials suppliers have participated on terms that their data will be treated confidentially. For urea gate-to gate data were provided, for kaolin, aluminium sulphate and additives cradle- to- gate data. For ammonia and fuel data from APME Ecoprofiles are used. For ammonium chloride no supplier data were availible.

	Instead litterature data (Ullman, p.256) were used. Raw materials used are mentioned under ''Object of study/Functions) Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1995 from ''Annual Energy Review 1997'' (European comission). Building of the power plant is not included.
Notes	

SPINE LCI dataset: Production of high-density polyethylene

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	Public

Technical System	
Name	Production of high-density polyethylene
Functional Unit	1 kg
Functional Unit Explanation	1 kg HDPE.
Process Type	Gate to gate
Site	Neste Polyeten AB Neste Polyeten AB Stenungsund
Sector	Materials and components
Owner	Neste Polyeten AB Neste Polyeten AB Stenungsund
Technical system description	The system consists of production of high-density polyethylene (HDPE). The raw material used is ethylene, which is delivered to the sight via pipeline. HDPE is polymerised in a fluidised bed of catalytic sand at a maximum of 110 deg. Celsius and 21 bar. The polymerisation catalyst (Ziegler-Natta catalyst) consists of metal compounds precipitated in extremely fine quarts sand. The base resin is removed from the reactor in the form of a powder, which is modified by the admixture of additives in an intensive mixer. The melted plastic material from the intensive mixer is converted into a pelletised product in subsequent extrusion and pelletising equipment.

System Boundaries	
Nature Boundary	In the system only emissions to air and water are accounted for at the nature boundary.
Time Boundary	
Geographical Boundary	
Other Boundaries	Raw material, the product and the energy consumption are accounted for.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1990

Data Type	Unspecified
Represents	Not relevant.
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992., where they have used data from the environmental report of Neste Polyeten AB in Stenungsund. Emission factors have been used for the calculation of the emissions from the burning of oil, apart from SO2 and NOx emissions, which have been measured.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992
Notes	In this inventory profile it is possible to identify which process step (Extruded profile production, Process scrap recycling) the flow is connected to and if it derives from the energy use, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity	2.101			MJ	Technosphere	
	Input	Refined resource	Ethylene	1.003			kg	Technosphere	Sweden
	Input	Refined resource	Thermal energy	0.113			MJ	Technosphere	
	Output	Emission	CFC	0.40			mg	Air	
Notes: The emission of CO2 are caused by flaring.	Output	Emission	CO2	49			g	Air	
Notes: Diffuse emissions and rejects.	Output	Emission	Ethylene	0.97			g	Air	
	Output	Emission	H2	0.176			g	Air	
	Output	Emission	NOx	14.16			mg	Air	
	Output	Emission	SO2	6.03			mg	Air	
	Output	Emission	TOC	11.83			mg	Water	
	Output	Product	HDPE	1			kg	Technosphere	
Notes: The oil waste is sent to SAKAB.	Output	Residue	Oil waste	0.40			g	Water	

About Inventory

Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (resonisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about packaging and the environment.
Detailed Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data are valid for Swedish conditions at a specific plant, but can be used as an approximation to other countries and other plants. One should though be aware of the fact that the situation in other countries may be very different and depending on this one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. The emissions caused by the production of the energy used in the system are not accounted for.
About Data	

Notes	

SPINE Data Report © SLC, Chalmers University of Technology, 2020 SLC - the Swedish life cycle center

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SPINE LCI dataset: Production of hot mix for asphalt pavement.

Administrative	
Finished	Y
Date Completed	2001-02-09
Copyright	
Availability	Public

Technical System	
Name	Production of hot mix for asphalt pavement.
Functional Unit	1 kg of hot mix.
Functional Unit Explanation	To get an idea of the order of magnitude of the functional unit, an example is the model of the asphalt pavement studied in the report: 1235 ton of hot mix are used per layer of 1 km road. The road is 13 m wide. 2 layers are needed for the construction of the road. 3 layers will be added during the maintenance operations over 40 years.
Process Type	Cradle to gate
Site	Sweden
Sector	Construction
Owner	Sweden
Technical system description	Production of hot mix. To produce hot mix, bitumen and aggregate are mixed at the asphalt mixing plant, the hot mix process also uses electricity and a fuel (EO oil). An asphalt additive can be added to the mix but is not included in this inventory. The plant is located in Sweden. The bitumen is received from a storage that is supplied by a Swedish refinery but the raw material (crude oil) is from Venezuela. The aggregate is a crushed rock quarried in the vicinity of the asphalt mixing plant. The inventory includes the production of the raw materials (bitumen and aggregate) as well as the production of the fuel (EO oil) in Norway. In general all flows are followed from the cradle (nature). The energy and material resources are traced back to the extraction of natural resources. The production of electricity used in different parts of the system studied have been included. The production of electricity includes operation and maintenance of the power plants and the production of fuel used for the electricity production. National electricity grids has been applied when no spcecific electricity supplier is known. All transports inlude the environmental load from cradle to gate: all inputs are tracked to the cradle, being material or energy.. (for instance the fuel production, cradle to gate is included) The following systems are the most importanat systems included: 1. At the asphalt mixing plant plant: For 1kg of hot mix, the material and energy required at the asphalt mixing plant are as follows: - Wetfix I (adhesion promoter) 240 mg (not included in this inventory) - Bitumen 0,06 kg - Aggregate 0.94 kg - Electricity 0,036 MJ - Heat from EO oil combustion 0,285 MJ Note that 10% of the raw material fed to the process are recovered during maintenance of the asphalt pavement. 90% of the bitumen and aggregate quantities given above are allocated an impact from cradle to the gate while the remaining 10% are considered as material inputs and are not followed from the cradle. 1.1. Heat The emissions due to heat production and the production of fuel for heat is inventoried from cradle to gate. It includes the extraction of the crude oil, the transports and the refining.

1.2. Bitumen
The bitumen inventory includes the extraction of bitumen in Venezuela, the transport by tanker to the refinery, the refining, the transport by ship to the storage, the storing, and the transport by lorry to the asphalt mixing plant. All energy requirements are tracked to the cradle (fuel or electricity).

1.2.1. Extraction of bitumen
The data for extraction in Venezuela are estimated with the help of different litterature references.

1.2.2. Refining
The refining in Nynäshamn is included.

1.2.3. Storage of bitumen
The emissions at the storage and cradle to gate inventory for the fuels used at the storage.

1.3. Aggregate
The aggregate inventory only includes emissions due to the combustion of fuel and the electricity production for the crushing and the transport of aggragate to the asphalt mixing plant by lorry. But this is considered to include most of the environmental load.
For the crushing, the same fuel as at the asphalt mixing plant is used.

2. Transports

2.1. To the refinery
The tanker was approximated by a Swedish model (max. capacity 300 000 ton) using heavy fuel oil with a sulphur content of 2,6%. The loading factor is of around 70% according to the competent personnel at the harbour of Nynäs. The distance between Venezuela and Nynäshamn is approximated to 10 000 km.

2.2. To the storage
A smaller tanker (4 400 ton) is used to model the transport between the refinery and the storage. The distance is 225 nautic miles (416,5 km) and the loading factor of the tanker is assumed to be 50%.

2.3. To the hot mix plant

2.3.1. Recovered material to the hot mix plant
The hot mix milled during maintenance is transported back to the hot mix plant by lorry. 10% of the raw materials for hot mix are recovered from the milled asphalt pavement. The transport of the recovered material is assumed to cover a distance of 50 km.

2.3.2. ''New'' material to the hot mix plant
The quarried and crushed aggregate is assumed to be transported over 5 km by lorry. The bitumen is assumed to cover a distance of 200 km by lorry between the storage and the asphalt mixing plant. Both lorries are 24 ton maximum total weight with a loading factor of 50%.

Over the total cradle to gate inventory, electricity is required, although the electricity input is tracked to the cradle and its impact is included (emissions and natural resource use), it is of interest to inform about the internal flow of electricity. The total electricity requirements are as follows:

Electricity - biomass 6,00e-04 kWh
Electricity - coal 4,55e-04 kWh
Electricity - hydro 9,08e-03 kWh
Electricity - natural gas 1,06e-04 kWh
Electricity - nuclear 8,75e-03 kWh
Electricity - oil 3,73e-05 kWh
Electricity - wind 4,99e-05 kWh

Note that the production of electricity is tracked to the cradle and included in the inventory (as natural resource use, emissions etc.).

For litterature references see: ''About data''

System Boundaries

Nature Boundary	No emissions from the asphalt mixing plant are included since they are not measured. The emissions derived from the heat use is however included. The aggregate inventory only includes emissions due to the combustion of fuel and the electricity production for the crushing and the transport of aggregate to the asphalt mixing plant by lorry. Different environmental impact due to different emissions in different geographical locations have not been taken into accont. All environmental flows of one substance from different locations have been added to one figure.
Time Boundary	Data were obtained between 1992 and 2001. They are applicable for hot mix used in a Swedish road today.

Geographical Boundary	One typical hot mix plant in Sweden (not average) has been studied. For bitumen, all the segments but the extraction are located in Sweden. For the aggregate, all segments are in Sweden Fuels come from Norway. Extraction of crude oil (bitumen) takes place in Venezuela.
Other Boundaries	Recycled material: Note that 10% of the raw material fed to the asphalt mixing plant are recovered during maintenance of the asphalt pavement. No environmental load are included for their production. They are displayed as refined resource input from the technosphere and are not followed from the cradle. Other boundaries: The transport of the different fuels from refinerys to the vehicle or the plant where it is combusted are not included. Environmental influence caused by the production of machines, industrial plants and infrastructure are not included.
Allocations	REFINING Although the crude oil contains 60-65% of bitumen, only 40% of the refinery's impact is allocated to the bitumen. The remaining 60% and the margin of efficiency are allocated to the lighter products of the refinery. This allocation is based on both mass and technological knowledge: the bitumen content in the crude oil is around 65% by mass but the lighter fractions have much higher energy requirements by mass unit for their processing. The lighter fractions also have a higher economical value.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	2001-02-09
Data Type	Derived, unspecified
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of hot mix asphalt pavement excluding the asphalt additives that are usually used.
Method	Data are from the appendix no. 6 in the litterature reference.
Literature Reference	RIES Adeline - ''Life cycle assessment of an adhesion promoter used in hot mix for asphalt pavement'' - Akzo Nobel / Chalmers University of Technology - 2001.
Notes	For the amount of hot mix required for 1 km of road, refer to the ''Functional unit explenation'' in the technical system.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Area	4.389566E-05			m2	Ground	
	Input	Natural resource	Bauxite	9.920868E-07			g	Ground	
	Input	Natural resource	Biomass	6.46235E-03			MJ	Ground	
Represents: Corresponds to 90% of the bitumen use. The remaining 10% are not tracked to the cradle since they come from recycled asphalt. Notes: The heat content of bitumen is around 39,8 MJ/kg.	Input	Natural resource	Bitumen	2.1492			MJ	Ground	
	Input	Natural resource	Coal	2.659041E-03			MJ	Ground	
	Input	Natural resource	Copper ore	1.869265E-02			g	Ground	
	Input	Natural resource	Crude oil	0.3522815			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power. Method: Electricity from hydro power is assumed to be produced with 80% efficiency.	Input	Natural resource	Hydro energy	4.100244E-02			MJ	Ground	

	Input	Natural resource	Iron ore	6.256482E-04			g	Ground	
	Input	Natural resource	Lead ore	2.369472E-04			g	Ground	
	Input	Natural resource	Natural gas	0.5261003			MJ	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant. Method: Electricity from nuclear power is assumed to be produced with 35% efficiency.	Input	Natural resource	Nuclear energy	9.091493E-02			MJ	Ground	
Represents: Corresponds to 90% of the aggregate use. The remaining 10% are not tracked to the cradle since they come from recycled asphalt. Notes: The aggregate is produced from rock.	Input	Natural resource	Rock	0.846			g	Ground	
	Input	Natural resource	Wind energy	1.796424E-04			MJ	Ground	
	Input	Natural resource	Wood	4.191829E-05			g	Ground	
Represents: 10% of the total aggregate use as a raw material. The remaining 90% is followed from the cradle. Method: 10% of the raw materials (aggregate and bitumen) used are from recycled asphalt. The environmental load from their production are not included.	Input	Refined resource	Aggregate	0.094			kg	Technosphere	
Represents: 10% of the total bitumen use as a raw material. The remaining 90% is followed from the cradle. Method: 10% of the raw materials (aggregate and bitumen) used are actually recycled asphalt. The environmental load from their production are not included. Notes: The heat content of bitumen is around 39,8 MJ/kg	Input	Refined resource	Bitumen	0.006			kg	Technosphere	
	Output	Emission	BOD	0.001026			g	Water	
	Output	Emission	CN-	1.034271E-06			g	Water	
	Output	Emission	CO	1.304907E-02			g	Air	
	Output	Emission	CO2	4.292318E-02			kg	Air	
	Output	Emission	COD	1.857717E-02			g	Water	
	Output	Emission	HCl	1.137304E-05			g	Air	
	Output	Emission	Hydrocarbons	0.000108			g	Water	
	Output	Emission	Hydrocarbons	0.1134514			g	Air	
	Output	Emission	Methane	6.537666E-03			g	Air	
	Output	Emission	N total	2.829003E-04			g	Water	
	Output	Emission	N2O	3.43707E-05			g	Air	
	Output	Emission	NH3	3.118506E-05			g	Water	
	Output	Emission	NOx	0.2867374			g	Air	
	Output	Emission	Oil	4.43322E-04			g	Water	
	Output	Emission	P total	0.000108			g	Water	
	Output	Emission	Particles	1.338738E-02			g	Air	
	Output	Emission	Phenol	1.939983E-06			g	Water	
	Output	Emission	SO2	0.1444601			g	Air	
	Output	Product	Hot mix	1			kg	Technosphere	
	Output	Residue	Catalyst waste	4.517981E-05			g	Technosphere	
	Output	Residue	Construction waste	6.122241E-04			g	Technosphere	
	Output	Residue	Hazardous waste	0.01424			g	Technosphere	
	Output	Residue	Highly radioactive waste	3.963524E-04			g	Technosphere	
	Output	Residue	Oil waste	2.773259E-03			g	Technosphere	
	Output	Residue	Other waste	0.9883429			g	Technosphere	

About Inventory	
Publication	RIES Adeline - ''Life cycle assessment of an adhesion promoter used in hot mix for asphalt pavement'' - Akzo Nobel / Chalmers University of Technology - 2001. -- Data documented by: Adeline Ries, thesis worker at Akzo Nobel Surface Chemistry Internal review at Akzo by: Klas Hallberg, Akzo Nobel Surface Chemistry Documentation review at CPM by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Akzo Nobel Surface Chemistry.
General Purpose	The purpose is to determine the environmental impact from a hot mix asphalt pavement on an average Swedish countryside road. It is possible to compare its impact with the impact from an adhesion promoter called Wetfix I. Then calculations can show how much the asphalt additive needs to extend the life of the asphalt pavement for the whole system to have a lower environmental load. If the adhesion promoter does not extend the life of the road at all an addition of it will simply increase the environmental load.
Detailed Purpose	To assess the environmental impact of a mass unit of asphalt pavement. To identify the segments of the life cycle that contribute most to the total impact.
Commissioner	- Akzo Nobel Surface Chemistry AB 444 85 Stenungsund Sweden.
Practitioner	Ries, Adeline - 47bis rue Saint Georges F-37210 Rochecorbon France.
Reviewer	Ramnäs, Olle - Chemical Environmental Science Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	Swedish hot mix production with bitumen from Venezuela. Since the transport of crude oil to the refinery is a big contributor to the environmental load, any change of vehicle, the fuel used or the distance would affect the results a lot. Some asphalt mixing plants may not use recovered material or to a different ratio. Since the raw materials are among the main sources of emissions and resource use, the fact that 10% of the raw materials are allocated no impact for in this model is of importance.
About Data	Most electricity used correspond with the Swedish average (electricity grid from 1999 and inventory for each electricity production published in 1997) [Brännström-Norberg et al., 1996], [Brännström, 1998] and [Directorate general for energy, 1999]. For the electricity used in other countries (Norway) respective electricity grids [Directorate general for energy, 1999] are used. Some fuels used are derived from Statoil activities in Norway (North-Sea extraction of crude oil, production of fuel...) [Statoil, 1999] Productions and transport: 1. At the asphalt mixing plant plant - Data are derived from the IVL report [Stripple, 1995] and from sources within Akoz Nobel Surface Chemistry regarding the use of Wetfix I. 1.1. Heat The emissions due to heat production are derived from the IVL report [Stripple, 1995]. The production of fuel for heat is inventoried from cradle to gate using Statoil's environmental report 1999 [Statoil, 1999]. 1.2.1. Extraction of bitumen The data for extraction in Venezuela are estimated. The data are derived from both the IVL study [Stripple, 1995] and the Statoil corresponding data for North-Sea crude oil extraction [Statoil, 1999]. 1.2.2. Refining The inventory is derived from [Stripple, 1995]. The oil used as a fuel at the refinery is estimated by data corresponding to crude oil from North-Sea [Statoil, 1999]. 1.2.3. Storage of bitumen The emissions at the storage and cradle to gate inventory for the fuel used at the storage are derived from the IVL study [Stripple, 1995]. This is the only inventory where the cradle to gate inventory for the fuel is not from Statoil. 1.3. Aggregate The aggregate data are derived from [Stripple, 1995]. 2. Transport data used are for average vehicles [NTM, 2000] The references mentioned above: [Brännström-Norberg et al., 1996]

	BRÄNNSTRÖM-NORBERG B-M., DETHLEFSEN U., JOHANSSON R., SETTERWALL C., TUNBRANT S. - ''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'' -1996 - Vattenfall AB pp 130. [Brännström, 1998] BRÄNNSTRÖM-NORBERG BRITT-MARIE - ''LCA för kol-Sammanfattnin goch jämförelse med Vattenfalls övriga livscykelanalyser för elproduction'' - 1998 - Vattenfall - pp 11. [Directorate general for energy, 1999] Directorate general for energy (DG XVII) - ''Annual energy review'' - 1999 [NTM, 2000] NTM - NÄTVERKET FÖR TRANSPORTER OCH MILJÖN - ''Network for Transport and the Environment'' - www.ntm.a.se - 2000. [Statoil, 1999] STATOIL - ''Annual Report 1999'' - 1999 - HES Accounting (available on the web) [Stripple, 1995] STRIPPLE HÅKAN - ''Livscykelanalys av väg - en modellstudie för inventering'' - IVL rapport IVL Svenska Miljöinstitutet AB - november 1995 - pp 106.
Notes	The bitumen is inventoried as a natural energy resource use. The use of bitumen in asphalt is indeed making the heat it contains unavailable and the use can be expressed in MJ thus making it possible to compare with other use of energy resources. The publication reports the results of the study of a system which includes the construction of the asphalt pavement and its maintenance over 40 years. In that system, the adhesion improver Wetfix I is used in the hot mix. The person stated as Reviewer were the examiner for the Master of Science thesis.

SPINE LCI dataset: Production of hot rolled steel rings

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Production of hot rolled steel rings
Functional Unit	One ton of hot rolled steel rings
Functional Unit Explanation	The steel rings produced in this study will be further processed into bearing rings and used for SKF spherical roller bearing 232/530.
Process Type	Gate to gate
Site	Ovako Steel AB SE-813 82 Hofors
Sector	Materials and components
Owner	Ovako Steel AB SE-813 82 Hofors
Technical system description	This activity is a subactivity for the whole system activity ''Production of bearing rings'' available in the SPINE@CPM database. When producing the bearing rings the forged steel bars need to be further processed into steel rings at at ring mill . This dataset represents the environmental impact from the making of steel rings from steel bars, 350 mm, at the ring mill at Ovako Steel AB in Hofors, Sweden. The production of the rings takes place at the ring mill (ring mill number 9) at Ovako Steel AB in Hofors, Sweden. The process steps for the inner and outer ring are completely the same, and therefore the process will be described only once. The forged bars (blanks) from Scana Steel AB in Söderfors are cut cold in a Wagner sawing machine and heated in rotating hearth furnaces. The blanks are then upset and pierced in a

	press. The pierced blanks are subject to intermediate heating in a batch furnace before finish rolling in an axial/radial rolling mill. The rings are rolled to a certain profile specific to the demands of SKF. After forging and rolling the rings have their final dimensions. The rings are heat treated to obtain the required material properties and the oxide scale formed during the treatment is then blasted off. The rings are finally checked and packed.

System Boundaries

Nature Boundary	Emission to air and water are included.
Time Boundary	All data refers to year 1999. No changes are planned for the nearest future.
Geographical Boundary	The production of steel rings takes place at the ring mill at Ovako Steel AB in Hofors, Sweden.
Other Boundaries	The production of LPG and Electricity are NOT included in this dataset, but must be followed from the cradle in order to obtain the complete environmental impact of this activity. No internal transport is considered.
Allocations	Allocations have been made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of hot mix asphalt pavement excluding the asphalt additives that are usually used.
Method	The data has been gathered from interviews with Eva-Maria Arvidsson at Ovako Steel AB in Hofors. Most data is monitored.
Literature Reference	RIES Adeline - ''Life cycle assessment of an adhesion promoter used in hot mix for asphalt pavement'' - Akzo Nobel / Chalmers University of Technology - 2001.
Notes	For the amount of hot mix required for 1 km of road, refer to the ''Functional unit explenation'' in the technical system.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity	537.79			kWh	Technosphere	Sweden
	Input	Refined resource	Emulsion	2.26			kg	Technosphere	Europe
	Input	Refined resource	Forged Bars	1227.02			kg	Technosphere	Europe
	Input	Refined resource	Grease	0.14			kg	Technosphere	Europe
	Input	Refined resource	Hydraulic Oil	0.96			kg	Technosphere	Europe
	Input	Refined resource	Liquefied petroleum gas	7499.84			MJ	Technosphere	Europe
	Input	Refined resource	Lubricating Oil	0.22			kg	Technosphere	Europe
	Input	Refined resource	Metal Ribbon	1.70			kg	Technosphere	Europe
	Input	Refined resource	Saw Blade	0.07			kg	Technosphere	Sweden
	Input	Refined resource	Tools	3.32			kg	Technosphere	Sweden
	Input	Refined resource	Wood Packing	45.00			kg	Technosphere	Europe
	Output	Co-product	Steel scrap	114.20			kg	Technosphere	Sweden
	Output	Emission	CO2	487.22			kg	Air	Europe
	Output	Emission	Emulsion	2.26			kg	Water	Europe
	Output	Emission	NOx	0.50			kg	Air	Europe
	Output	Product	Hot rolled steel rings	1000.00			kg	Technosphere	Sweden
	Output	Residue	Grease	0.14			kg	Technosphere	Europe
	Output	Residue	Grindings	29.38			kg	Technosphere	Sweden
	Output	Residue	Hydraulic Oil	0.96			kg	Technosphere	Europe
	Output	Residue	Lubricating Oil	0.22			kg	Technosphere	Europe
	Output	Residue	Metal Ribbon	1.70			kg	Technosphere	Europe
	Output	Residue	Oxide scale	27.89			kg	Technosphere	Sweden
	Output	Residue	Tools	3.32			kg	Technosphere	Sweden
	Output	Residue	Wood Packing	15.00			kg	Technosphere	Sweden

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data are applicable to the production of steel rings from forged steel bars, 350 mm, at the Ring Mill at Ovako Steel in Hofors, Sweden.
About Data	Data is gathered from interviews with Eva-Maria Arvidsson at Ovako Steel AB in Hofors, Sweden.
Notes	

SPINE LCI dataset: Production of hydrogen (cracker) (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of hydrogen (cracker) (APME)
Functional Unit	1 kg hydrogen (from cracker)
Functional Unit Explanation	Typical uses for hydrogen is mainly for hydrogenation reactions, as reducing agent in metals production and as a fuel. Hydrogen (cracker) is one of several products produced in a cracker, among ethylene, propylene and a mixture of butene isomers.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. All flows have been followed to the cradle. However, only the main production process is been described here. The hydrogen is a by-product from the process described below. In this dataset, it is the hydrogen that is of main interest. The output fractions from an oil refinery are complex mixtures of predominantly unreactive saturated hydrocarbons. The first processing step in converting such fractions into feedstock suitable for the petrochemical industries is cracking. Essentially a cracker performs two functions in (a) reducing the complexity of the input mixture into a smaller number of low molecular mass hydricarbons and (b) introducing unsaturation into the hydrocarbons so that they become more reactive. Cracking is a three-stage process. Although it is possible to identifiy schematically the three processes, in practise, they behave as a single unit and information on the process characteristics is usually available only for the overall system. The raw hydrocarbon feed from the refinery is fed to the furnace section where it is raised

	to a high temperature. The reaction products that are formed depend upon the composition of the feed, the temperature of the furnace and the residence time. The cracker operator chooses temperature and residence time to optimise product mix from a given feed. Upon leaving the furnace, the hydrocarbon gas is quench cooled to inhibit further reactions. It is then passed to the separation stage where the individual hydrocarbons are separated from one another by fractional distillation. The principal products from the cracker are ethylene (ethene), propylene (propene) and a mixture of butene isomers. Usually there will be some hydrogen and a number of other hydrocarbons, some of which will be separated, others will be fed back to the furnace and yet others will be used as fuels. Cracker feeds may be naphtha from oil refining or natural gas or a mixture of both. Frequently, other refinery hydrocarbons are also used. When natural gas feeds are used, the primary function of the cracker is to introduce unsaturation into the molecules. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries	
Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1990-1996. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 10 hydrogen crackers in OECD countries in Western Europe. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Metholodgy report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 10 hydrogen crackers in OECD countries in Western Europe. Their total production was 810,000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery

	products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1990-1996
Data Type	Derived, mixed
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of hot mix asphalt pavement excluding the asphalt additives that are usually used.
Method	European average data. Results are based on data supplied by 10 hydrogen crackers in OECD countries in Western Europe. Their total production was 810,000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME - Association of Plastics Manufacturers in Europe, website: http://lca.apme.org
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Air	36119.80553			mg	Air	Europe
	Input	Natural resource	Barytes	4.24E-02			mg	Ground	Europe
	Input	Natural resource	Bauxite	479.8385613			mg	Ground	Europe
	Input	Natural resource	Bentonite	182.0913823			mg	Ground	Europe
	Input	Natural resource	Biomass	89.10697713			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	18.16519			mg	Ground	Europe
	Input	Natural resource	Chalk	2.36E-22			mg	Ground	Europe

	Input	Natural resource	Chromium in ore	2.99E-05			mg	Ground	Europe
	Input	Natural resource	Clay	14.621427			mg	Ground	Europe
	Input	Natural resource	Crude oil	521056.8362			mg	Ground	Europe
	Input	Natural resource	Dolomite	7.236272291			mg	Ground	Europe
	Input	Natural resource	Feldspar	4.09E-28			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	0.537807158			mg	Ground	Europe
	Input	Natural resource	Fluorite	0.364628281			mg	Ground	Europe
	Input	Natural resource	Granite	7.29E-03			mg	Ground	Europe
	Input	Natural resource	Gravel	2.184628087			mg	Ground	Europe
	Input	Natural resource	Hard coal	16173.48696			mg	Ground	Europe
	Input	Natural resource	Hydro energy	1.96E-02			MJ	Ground	Europe
	Input	Natural resource	Iron in ore	665.1426293			mg	Ground	Europe
	Input	Natural resource	Lead in ore	4.60E-02			mg	Ground	Europe
	Input	Natural resource	Lignite	491.6055852			mg	Ground	Europe
	Input	Natural resource	Limestone	732.9430512			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	238.825861			mg	Ground	Europe
	Input	Natural resource	Natural gas	886735.6258			mg	Ground	Europe
	Input	Natural resource	Nickel in ore	6.99E-06			mg	Ground	Europe
	Input	Natural resource	Nitrogen	9740.016942			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	0.145053086			MJ	Ground	Europe
	Input	Natural resource	Olivine	5.554968058			mg	Ground	Europe
	Input	Natural resource	Oxygen	29.624076			mg	Ground	Europe
	Input	Natural resource	Peat	1.335478381			mg	Ground	Europe
	Input	Natural resource	Phosphate	0.202100021			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	0.824032432			mg	Ground	Europe
	Input	Natural resource	Rutile	3.39E-22			mg	Ground	Europe
	Input	Natural resource	Sand	73.77919637			mg	Ground	Europe
	Input	Natural resource	Shale oils	51.42565289			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	1121.73237			mg	Ground	Europe
	Input	Natural resource	Sulphur	37.22849014			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	18.60710247			mg	Ground	Europe
	Input	Natural resource	Water, cooling	108389727.9			mg	Water	Europe
	Input	Natural resource	Water, process	2316057			mg	Water	Europe
	Input	Natural resource	Wood	1.580154864			mg	Ground	Europe
	Input	Natural resource	Zinc in ore	1.73E-03			mg	Ground	Europe
	Output	Co-product	Recovered energy	3.088793244			MJ	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	7.52E-08			mg	Air	Europe
	Output	Emission	Acid as H+	42.35634006			mg	Water	Europe
	Output	Emission	Al	1.07E-02			mg	Water	Europe
	Output	Emission	Aldehydes	1.80E-03			mg	Air	Europe
	Output	Emission	As	9.77E-07			mg	Water	Europe
	Output	Emission	BOD5	5.262182284			mg	Water	Europe
	Output	Emission	Ca2+	0.406976228			mg	Water	Europe
	Output	Emission	CFCs	1.429324447			mg	Air	Europe
	Output	Emission	Chloroorganics	1.07E-03			mg	Air	Europe
	Output	Emission	Chloroorganics	1.94E-04			mg	Water	Europe
	Output	Emission	Cl-	254.9711486			mg	Water	Europe
	Output	Emission	Cl2	6.92E-05			mg	Water	Europe
	Output	Emission	Cl2	7.95E-02			mg	Air	Europe
	Output	Emission	CN-	4.34E-03			mg	Water	Europe
	Output	Emission	CO	656.1808138			mg	Air	Europe
	Output	Emission	CO2	1154516.364			mg	Air	Europe
	Output	Emission	CO32-	326.4440908			mg	Water	Europe
	Output	Emission	COD	185.1622654			mg	Water	Europe
	Output	Emission	CrO3	3.60E-05			mg	Water	Europe
	Output	Emission	CS2	1.36E-07			mg	Air	Europe
	Output	Emission	Cu	3.81E-02			mg	Water	Europe
	Output	Emission	Dissolved organics	25.09762504			mg	Water	Europe
	Output	Emission	Dissolved solids	54.53527014			mg	Water	Europe
	Output	Emission	F-	8.67E-03			mg	Water	Europe
	Output	Emission	F2	2.17E-04			mg	Air	Europe
	Output	Emission	Fe	0.118761744			mg	Water	Europe
	Output	Emission	H2	50.78298493			mg	Air	Europe
	Output	Emission	H2S	2.07E-02			mg	Air	Europe
	Output	Emission	H2SO4	6.85E-07			mg	Air	Europe

	Output	Emission	HCl	7.761343767			mg	Air	Europe
	Output	Emission	HCN	1.16E-27			mg	Air	Europe
	Output	Emission	HF	0.21303603			mg	Air	Europe
	Output	Emission	Hg	0.109273247			mg	Air	Europe
	Output	Emission	Hg	6.25E-03			mg	Water	Europe
	Output	Emission	K+	2.41E-02			mg	Water	Europe
	Output	Emission	Metals	1.272021647			mg	Air	Europe
	Output	Emission	Metals	458.7008509			mg	Water	Europe
	Output	Emission	Methane	3609.734844			mg	Air	Europe
	Output	Emission	Mg	2.88E-02			mg	Water	Europe
	Output	Emission	N total	3.705377876			mg	Water	Europe
	Output	Emission	N2O	4.82E-02			mg	Air	Europe
	Output	Emission	Na	70.35773767			mg	Water	Europe
	Output	Emission	NH3	1.33E-03			mg	Air	Europe
	Output	Emission	NH4+	1.110788708			mg	Water	Europe
	Output	Emission	Ni	3.81E-02			mg	Water	Europe
	Output	Emission	NO3-	0.244345539			mg	Water	Europe
	Output	Emission	NOx	4594.003977			mg	Air	Europe
	Output	Emission	Oil	38.04260655			mg	Water	Europe
	Output	Emission	Other organics	7.26E-02			mg	Water	Europe
	Output	Emission	PAH	1.89E-28			mg	Air	Europe
	Output	Emission	Particles	484.1331294			mg	Air	Europe
	Output	Emission	Pb	1.94E-04			mg	Air	Europe
	Output	Emission	Pb	4.29E-04			mg	Water	Europe
	Output	Emission	Phenol	0.844059891			mg	Water	Europe
	Output	Emission	PO43-	0.585669762			mg	Water	Europe
	Output	Emission	S2-	0.213277259			mg	Water	Europe
	Output	Emission	SO2	2392.183238			mg	Air	Europe
	Output	Emission	SO42-	153.2165376			mg	Water	Europe
	Output	Emission	Suspended solids	208.3486922			mg	Water	Europe
	Output	Emission	Thiols	4.34E-05			mg	Air	Europe
	Output	Emission	Vinyl chloride	4.41E-25			mg	Water	Europe
	Output	Emission	Vinyl chloride	4.77E-08			mg	Air	Europe
	Output	Emission	VOC	0.900605341			mg	Air	Europe
	Output	Emission	VOC	909.5801907			mg	Air	Europe
	Output	Emission	VOC (hydrocarbons, oil)	36.13540136			mg	Water	Europe
	Output	Emission	VOC, aromatic	4.375316176			mg	Air	Europe
	Output	Emission	Zn	2.73E-03			mg	Water	Europe
	Output	Product	Hydrogen (cracker)	1			kg	Technosphere	Europe
	Output	Residue	Construction	1.88E-02			mg	Ground	Europe
	Output	Residue	Industrial	432.5499016			mg	Ground	Europe
	Output	Residue	Inert chemical	839.3013036			mg	Ground	Europe
	Output	Residue	Metals	7.115119392			mg	Ground	Europe
	Output	Residue	Mineral	5108.272534			mg	Ground	Europe
	Output	Residue	Paper	1.20E-21			mg	Ground	Europe
	Output	Residue	Plastics	5.224526094			mg	Ground	Europe
	Output	Residue	Regulated chemical	222.8935784			mg	Ground	Europe
	Output	Residue	Slags & ashes	903.4004454			mg	Ground	Europe
	Output	Residue	To incinerator	255.5892639			mg	Technosphere	Europe
	Output	Residue	To recycling	3.95E-02			mg	Technosphere	Europe
	Output	Residue	Unspecified	5.277749653			mg	Ground	Europe
	Output	Residue	Wood waste	1.58E-02			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for hydrogen. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. -- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 3 April 2002 --

Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .
Reviewer	Not available -
Applicability	European average data. Results are based on data supplied by 10 hydrogen crackers. Their total production was 810,000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for hydrogen production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of hydrogen in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg)

	for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

SPINE LCI dataset: Production of injection moulding

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	

Technical System	
Name	Production of injection moulding
Functional Unit	1 kg
Functional Unit Explanation	1 kg injection moulding of high-pressure polyethylene
Process Type	Gate to gate
Site	
Sector	Consumer goods
Owner	
Technical system description	Production of injection moulding of high-pressure polyethylene

System Boundaries	
Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	Only energy consumption are accounted for in the system.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1991
Data Type	Unspecified
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of hot mix asphalt pavement excluding the asphalt additives that are usually used.
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992, where the data is based on both information from Lars Karlsson, Rosenlewen Emballage AB and Chalmers Industripark, Resurs- och avfallssnäla förpackningar, Electrolux-PADD'', 1990, Göteborg.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: The energy requirement for the manufacture of blow-moulded products has been assumed to be at the same level as that for film manufacture. This figure is based on information from Chalmers Industripark, Resurs- och avfallssnäla förpackningar, Electrolux-PADD'', 1990, Göteborg.	Input	Refined resource	Electricity	3.10			MJ	Technosphere	
	Output	Product	Injection moulding	1			kg	Technosphere	
Notes: The waste injection moulding is recycled.	Output	Residue	Injection moulding	0.136			kg	Technosphere	

About Inventory	
Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. --- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology ---
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study conserning packaging and the environment.
Detailed Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. There is no raw material going in to the system, which most lightly is the case. The raw material is high-pressure polyethylene. The emissions caused by the production of the electricity used in the system are not accounted for.
About Data	
Notes	

SPINE LCI dataset: Production of insulation glass wool

Administrative	
Finished	Y
Date Completed	2002-03-03
Copyright	The declaration does not say if there are any copyrights.
Availability	Public

Technical System	
Name	Production of insulation glass wool
Functional Unit	1 kg glass wool.
Functional Unit Explanation	The functional unit of 1 kg insulation glass wool gives the possibility to compare different suppliers of glass wool insulation.
Process Type	Gate to gate
Site	Sweden
Sector	Manufacturing

Owner	Sweden
Technical system description	The production of glass wool starts with the melting of the raw material, together with additives in a furnace. The excess energy is used for heating the industry. The binding agent is added to the compound at the same time as a spinning machine turns the material into thin threads. In the furnace the binding agent is cured and the glass wool insulation is cold down and cut into the right size.

System Boundaries

Nature Boundary	Emissions to air are included. Emissions to water or soil are not included. What happens after the emissions are released is not included, for example when the emissions react with compounds in the air and affects the environment in another ways.
Time Boundary	The data is from 2002 and as soon as there are any changes the environmental product declaration is updated.
Geographical Boundary	The data is from a Swedish company and everything within the system is in Sweden.
Other Boundaries	The inventory data contains data for production of glass wool and the energy consumption when producing glass wool. Extraction of resources, transportation, use during its lifetime and waste handling are not included. Production of electricity is also not included.
Allocations	The environmental product declaration does not say how the allocation is made when the industry produce more than one product.
Systems Expansions	Not relevant.

Flow Data

General Activity QMetaData

Date Conceived	2002-01-01--2002-06-01
Data Type	Derived, unspecified
Represents	Not relevant.
Method	Data is acquired from an environmental product declaration of glass wool from Saint-Gobain Isover AB, 2002-03-03.
Literature Reference	''Byggvarudeklaration for Isover Gullfiber glasull'', Saint-Gobain Isover AB, 2002-03-03
Notes	Prepared for SPINE by Annika Olsson.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Borax	89			g	Technosphere	Europe
	Input	Refined resource	Dolomite	41			g	Technosphere	Europe
	Input	Refined resource	Electricity	9.14			MJ	Technosphere	Europe
	Input	Refined resource	Feldspar	13			g	Technosphere	Europe
	Input	Refined resource	Formaldehyde	46			g	Technosphere	Europe
Notes: Natural gas	Input	Refined resource	Gas	9.9			MJ	Technosphere	Europe
	Input	Refined resource	LPG	0.14			MJ	Technosphere	Europe
	Input	Refined resource	Mangan dioxide	7			g	Technosphere	Europe
	Input	Refined resource	Mineral oil	7			g	Technosphere	Europe
	Input	Refined resource	Recycled glas	670			g	Technosphere	Europe
	Input	Refined resource	Sand	131			g	Technosphere	Europe
	Input	Refined resource	Sodium nitrate	4			g	Technosphere	Europe
	Input	Refined resource	Sodium nitrate	74			g	Technosphere	Europe
	Input	Refined resource	Urea	25			g	Technosphere	Europe
	Output	Emission	CO2	592			g	Air	Europe
	Output	Emission	NH3	3			g	Air	Europe
	Output	Emission	Particles	1			g	Air	Europe
	Output	Product	Glass wool	1000			g	Technosphere	Europe
	Output	Residue	Waste to incineration	107			g	Technosphere	Europe

About Inventory

Publication	Environmental product declaration, Saint-Gobain Isover, 2002-03-03 -- Data documented by: Annika Olsson, 2002-10-10

	Documentation reviewed by: Karolina Flemström, IMI, Chalmers University of Technology Published in SPINE@CPM: 2002-12-10 --
Intended User	The intended user of this inve
General Purpose	The purpose for an environment product declaration is to inform customers and other interested parties of the impact of the environment for a specific product. Also to give the possibility to compare two different, but similar, products or suppliers.
Detailed Purpose	In this case the specific purpose is to use the inventory data for insulation in a master´s thesis: Life-cycle assessment of two ventilation systems, by Annika Olsson, Chalmers University of Technology, 2002.
Commissioner	Lindab Ventilation AB - .
Practitioner	Olsson, Annika - - .
Reviewer	Bogeskär, Malin -
Applicability	The data are from a specific company producing glass wool and the data is only applicable for this company. The functional unit of 1 kg insulation glass wool may not be the best functional unit if the purpose of a study is to compare two different insulation materials, since it does not say anything about the main function of the insulation. The main function for insulation is the ability to insulate and thermal conductivity describes the material's ability to keep air still in the insulation and to reduce heat radiation. A good functional unit in this case would be the ability to insulate. Thermal conductivity is the most important characteristic for an insulating material. Thermal conductivity describes the material capacity of heat transmission. The rate of the thermal conductivity for an insulating material should be as low as possible. Materials with a low thermal conductivity have a good ability to minimize the convection in the insulation and reduce heat radiation. The conductivity varies between 0.030 and 0.045 W/m°C depending on the structure of the insulation. Thermal conductivity increases with increased temperature. Glass wool has low weight, is resilient and has good resistance to external influence. It is suited for soft insulation products like insulation for spiral ducts and technical insulation for sheets and sheeting.
About Data	The environmental product declaration, this documenation is based on, does not describe any methods for acquire numerical data. They are certified according to ISO 14001. The company follows the regulation from EU and the BYKR (Byggsektorns Kretsloppsråd) the data will be up-dated as soon as there are any changes. The data has been used without any changes of the Environmental product declaration performed by Saint-Gobain Isover.
Notes	

SPINE LCI dataset: Production of insulation rock wool

Administrative	
Finished	Y
Date Completed	2000-04-01
Copyright	The declaration does not say if there are any copyrights.
Availability	Public

Technical System	
Name	Production of insulation rock wool
Functional Unit	1 kg rock wool.

Functional Unit Explanation	The functional unit of 1 kg insulation rock wool gives the possibility to compare different suppliers of rockwool insulation.
Process Type	Gate to gate
Site	Sweden
Sector	Manufacturing
Owner	Sweden
Technical system description	The production of rock wool starts with the melting of the raw material, together with additives in a furnace. The excess energy is used for heating the industry. The binding agent is added to the compound at the same time as a spinning machine turns the material into thin threads. In the furnace the binding agent is cured and the rockwool insulation is cold down and cut into the right size. The rock wool is for transporting heated or cooled air in a ventilation system, so the mineral wool has a surface of prestressed aluminum foil on one side. The aluminum foil is used to prevent to much heatlosses when the ambient air is cooler than the air in the ducts. The foil is also used to prevent the air from condensate.

System Boundaries

Nature Boundary	The nature boundaries includes the emission to air from the production of rock wool. Emissions to water or soil are not included. What happens after the emissions are released is not included, for example when the emissions react with compounds in the air and affects the environment in another ways.
Time Boundary	The data is from 2000 and there are no known time limitation when using this data.
Geographical Boundary	The data is from a Swedish company and everything within the system is in Sweden.
Other Boundaries	The inventory data contains data for production of rockwool. The stone raw material consist of diabase and lime and the extraction of these resources is included. The extraction and production of the packaging material is included. The electricity consumption for all parts is added together to one number. Extraction of following refined resources: ammonia, formaldehyde, phenol and urea is not included. Transportation, use during its lifetime and waste handling is also not included.
Allocations	The environmental product declaration does not say how the allocation is made when the industry produce more than one product.
Systems Expansions	Not relevant

Flow Data

General Activity QMetaData

Date Conceived	2002-05-28--2002-06-30
Data Type	Derived, unspecified
Represents	Not relevant.
Method	Data is acquired from an environmental product declaration of rock wool from Paroc AB, 2000-04-01
Literature Reference	''Environmental product declaration for thermal insulation'', Paroc AB, 2000-04-01
Notes	Prepared for Ecolab by Annika Olsson. Checked by Malin Bogeskär.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Ammonia	2			g	Air	Europe
	Input	Refined resource	Coal	7.9			MJ	Technosphere	Europe
	Input	Refined resource	Crude oil	2.5			MJ	Technosphere	Europe
	Input	Refined resource	Electricity	4.8			MJ	Technosphere	Europe
	Input	Refined resource	Formaldehyde	22			g	Technosphere	Europe
	Input	Refined resource	Mineral oil	5			g	Technosphere	Europe
	Input	Refined resource	Phenol	8			g	Technosphere	Europe

	Input	Refined resource	Polyethylene film	37			g	Technosphere	Europe
Notes: The stone raw material consist of diabase, dolomite, lime, bauxite and slag	Input	Refined resource	Stone raw material	1569			g	Technosphere	Europe
	Input	Refined resource	Urea	8			g	Technosphere	Europe
	Output	Emission	CO2	1060			g	Air	Europe
	Output	Emission	Formaldehyde	0.3			g	Air	Europe
	Output	Emission	NOx	0.3			g	Air	Europe
	Output	Emission	Particles	3			g	Air	Europe
	Output	Emission	Phenol	0.3			g	Air	Europe
	Output	Emission	SO2	0.5			g	Air	Europe
	Output	Product	Rock wool	1			kg	Technosphere	Europe
	Output	Residue	Mineral waste	460			g	Technosphere	Europe

About Inventory	
Publication	Environmental product declaration, Paroc AB, 2000-04-01 --- Data documented by: Annika Olsson, 2002-10-10 Documentation reviewed by: Karolina Flemström, IMI, Chalmers University of Technology Published in SPINE@CPM: 2002-12-10 ---
Intended User	The intended user of this inve
General Purpose	The general purpose for this data inventory is to document environmental product declararation data in a way suitable for LCA studies.
Detailed Purpose	In this case the specific purpose is to use the inventory data for insulation in a master´s thesis: Life-cycle assessment of two ventilation systems, by Annika Olsson, Chalmers University of Technology, 2002. The purpose for an environment product declaration is to inform customers and other interested parties of the impact of the environment for a specific product. Also to give the possibility to compare two different, but similar, products or suppliers.
Commissioner	Lindab Ventilation AB - .
Practitioner	Annika Olsson - .
Reviewer	Bogeskär, Malin -
Applicability	The data are from a specific company producing rockwool and the data is only applicable for this company. The functional unit of 1 kg insulation rock wool may not be the best functional unit if the purpose of a study is to compare two different insulation materials, since it does not say anything about the main function of the insulation. The main function for insulation is the ability to insulate and thermal conductivity describes the material's ability to keep air still in the insulation and to reduce heat radiation. A good functional unit in this case would be the ability to insulate. Thermal conductivity is the most important characteristic for an insulating material. Thermal conductivity describes the material capacity of heat transmission. The rate of the thermal conductivity for an insulating material should be as low as possible. Materials with a low thermal conductivity have a good ability to minimize the convection in the insulation and reduce heat radiation. The thermal conductivity varies between 0.030 and 0.045 W/m°C depending on the structure of the insulation. Thermal conductivity increases with increased temperature. Rock wool is often used when the method of application is high temperature or high demands of fire resistance. Rock wool is also used if there are demands for high compression strength, for example in the ground. When the temperature of the air is below the temperature of the ambient air there is a risk for condensate to occur at the outside of the ducts. To prevent this the ducts must be provided with an insulation that keeps the surface temperature higher than the dew point for the ambient air. For this condensation prevention a steam break is needed. When the temperature of the air is higher than the ambient temperature, it is of great importance to eliminate as much heat losses as possible. For the minimization of heat losses a thermal insulation is needed. For the ability to use hot or cool air in the duct system, mineral wool with a surface of prestressed aluminum foil on one side is needed. The aluminum foil works as a steam break. The thickness of the insulation in this case is set to 100 mm. The thickness is a normal thickness of insulation for ventilation systems and with this thickness the heat losses will be at an acceptable level. The theoretical heat loss for ducts with a diameter of 200 mm, an airflow of 5 m/s and a 20 °C temperature difference between the indoor temperature and

	the ambient air is 0,035 °C per unit of length. With larger diameter and larger insulation thickness the temperature loss will be reduced.
About Data	The environmental product declaration, this documenation is based on, does not describe any methods for acquire numerical data. They are certified according to ISO 14001. Because the company follows the regulation from EU and the BYKR (Byggsektorns Kretsloppsråd) the data will be up-dated as soon as there are any changes. The data has been used without any changes of the Environmental product declaration performed by Paroc AB.
Notes	

SPINE LCI dataset: Production of iron oxide

Administrative	
Finished	Y
Date Completed	1993
Copyright	
Availability	Public

Technical System	
Name	Production of iron oxide
Functional Unit	1 kg
Functional Unit Explanation	1 kg iron oxide
Process Type	Cradle to gate
Site	Malmberget, Kiruna
Sector	Metal and mineral mining
Owner	Malmberget, Kiruna
Technical system description	LKAB´s mining and quarrying is located in Kiruna and Malmberget. The system includes quarrying, fine crushing, dressing, enriching and the pellet making. Except these processing steps heating plants, internal transports and other running operations are included.

System Boundaries	
Nature Boundary	Emissions to air and water are accounted for.
Time Boundary	
Geographical Boundary	The system is located in Kiruna and Malmberget in Sweden.
Other Boundaries	The energy consumption and the waste are accounted for.
Allocations	The environmental load for the different steps in the production of pellets are added and shown for the produced amount of pellets.
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1993
Data Type	Unspecified
Represents	Not relevant.

Method	The data are taken from Erlandsson M (KTH), Jönsson Å (CTH), Comparatative Life Cycle Assesment of concrete tiles, clay tiles and roofing sheet metal, Technical Environmental Planning, Chalmers University of Technology, Sweden, 1993
Literature Reference	Erlandsson M (KTH), Jönsson Å (CTH), Comparatative Life Cycle Assesment of concrete tiles, clay tiles and roofing sheet metal, Technical Environmental Planning, Chalmers University of Technology, Sweden, 1993
Notes	The emissions for the combustion of the fuels are accounted for.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: The value 30 MJ/kg has been used to calculate the energy consumption of coal in MJ.	Input	Refined resource	Coal	0.21			MJ	Technosphere	
Method: The value 37000 MJ/m3 has been used to calculate the energy consumption of diesel in MJ.	Input	Refined resource	Diesel	0.03			MJ	Technosphere	
	Input	Refined resource	Electricity	0.11			MJ	Technosphere	
Method: The value 39000 MJ/m3 has been used to calculate the energy consumption of oil in MJ.	Input	Refined resource	Oil	0.24			MJ	Technosphere	
	Output	Emission	CO2	41			g	Air	Sweden
Notes: the dust that is separated in the flourcleaning plant is collected and then dumped.	Output	Emission	Dust	0.266			g	Air	Sweden
Notes: The HCl emissions come from the Cl that is separated from the iron ore	Output	Emission	HCl	0.040			g	Air	Sweden
	Output	Emission	HF	0.020			g	Air	Sweden
Method: The nitrogen emissions are cased by the use of explosives. The total amount of nitrogen, in the explosives, is estimated to be a third of the weight of the explosives. The largest, legal emission is set to be 5% of the total amount of used explosives. This results in a maximum emission of 17g/kg explosives, which is equivalent to 0,0021 g/kg pellets iron oxide. Notes: The consumption of explosives contributes with emissions of nitrogen to the recipient via the sand storage.	Output	Emission	N	0.021			g	Water	
	Output	Emission	NOx	0.259			g	Air	Sweden
Method: The emissions of SO2 are based on both energy related emissions and the theoritical content in the ore. The two parts are approximately of the same size.	Output	Emission	SO2	0.252			g	Air	Sweden
Notes: In the shape of pellets	Output	Product	Iron oxide	1			kg	Technosphere	
	Output	Residue	Hazardous waste	0.028			g	Technosphere	
Notes: Consist of gråberg, that has been sorted out at the enrichment stage.	Output	Residue	Mining waste	935			g	Technosphere	

About Inventory

Publication	Erlandsson M (KTH), Jönsson Å (CTH), Comparatative Life Cycle Assesment of concrete tiles, clay tiles and roofing sheet metal, Technical Environmental Planning, Chalmers University of Technology, Sweden, 1993 -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about roofing materials.
Detailed Purpose	To calculate the environmental impact of cement production and further, the environmental impact of concrete tile production.
Commissioner	

Practitioner	Jönsson, Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden .
Reviewer	
Applicability	All internal transports are accounted for in the table, in terms of energy consumption and emissions caused by the combustion, except a transport by rail, between Svappavaara and Kiruna. This distance is estimated to be 45 km. Emissions due to stationary combustion in the process are also accounted for.
About Data	
Notes	

SPINE LCI dataset: Production of iron oxide yellow colorant containing Bermodol SPS 2532

Administrative	
Finished	Y
Date Completed	2004-04-01
Copyright	
Availability	Public

Technical System	
Name	Production of iron oxide yellow colorant containing Bermodol SPS 2532
Functional Unit	1 kg
Functional Unit Explanation	Since the amount of colorant used depend on the specific color the customer wants it's not possible to use ''enough colorant to paint a square meter of wall'' without also specifying a specific shade of iron oxide yellow. Therefore 1 kg is used instead. To give an idea of the magnitude of the Functional unit: A couple of drops of colorant are normally used in a can of paint.
Process Type	Cradle to gate
Site	Sweden
Sector	
Owner	Sweden
Technical system description	The Colorant is produced by mixing polyethylene glycol, iron oxide yellow pigment, water and Bermodol SPS 2532. The plant is located in Sweden. Bermodol SPS 2532 is received from Akzo Nobel in Stenungsund, Sweden. The pigment is produced in Germany. Local water is used and the use of water is assumed to cause no environmental impacts. Polyethylene glycol is produced in the Netherlands. In general all flows are followed from the cradle (nature). The energy and material resources are traced back to the extraction of natural resources. National electricity grids have been used when the specific electricity supplier is unknown. The following are the most important systems included: 1. At the colorant manufacturer For 1kg of colorant these are the material requirements: Pigment 0,54kg Bermodol SPS 2532 0,23kg Water 0,20kg Polyethyleneglycol 0,03kg The production of the colorant is a simple mixing of the ingredients and according to the manufacturer it causes no emissions and uses very little energy. 1.1. PolyethyleneGlycol Since no data could be found for the production of polyethylene glycol in the Netherlands data for the production of polyethylene glycol at Akzo Nobel in Stenungsund, Sweden is used instead.

	1.2. Pigment Since data from the pigment manufacturer in Germany could not be used, cradle to gate data for production of iron oxide in Sweden is used instead. 1.3 Bermodol SPS 2532 The Bermodol SPS 2532 inventory includes cradle to gate data for the raw materials needed and for the steam that is used in the process. All important transports are also included in the inventory. Since the study is cradle to gate, the data in the flow table are the emissions and the resource use needed to manufacture: The colorant, all the raw materials needed to produce the colorant, and so on all the way back to the extraction of natural resources from the cradle (nature). Many of the raw materials (Glycol and Bermodol SPS 2532) are to some extent petrochemical and oil is used both as an energy carrier and as the main component of petrochemical materials. Oil use is accounted for in MJ regardless whether it's used as an energy carrier or not.

System Boundaries

Nature Boundary	No emissions from the colorant manufacturer are included since they are not measured. Different environmental impacts depending on the geographical location of the emission have not been considered. All material flows of the same substance are added together, regardless of where they originate.
Time Boundary	Data is chosen to model the production of colorant in 2003 as accurately as possible.
Geographical Boundary	The production of colorant and Bermodol SPS 2532 is locvated in Sweden The pigment is produced in Germany and the glycol is produced in the Netherlands.
Other Boundaries	Environmental impacts caused by the production of machines, production plants and infrastructure is not included, neither is the environmental impact caused by the employees involved in the manufacture of the colorant and its raw materials. Only emissions and resource use that are considered to be relevant from an environmental point of view are included. Thus the use of air and water as natural resources is not included. Compounds that are emitted or used in small amounts compared to their environmental hazardousness or scarcity are also excluded from the inventory. All major transports are included. Emission data from transports in Sweden is based on simulations conducted by Volvo trucks and Scania in 1997. Transports in Europe is based on supplied values for Euro II engine with ECL-diesel. The emission and resource use data for environmental class 1 diesel has been taken from a life cycle inventory of the vehicle fuels presented by the Swedish transport and communications research board (KFB)
Allocations	Allocations have been done exclusively on mass basis. For example, when emission data from environmental reports, or data that covers the emission from an entire production plant the emissions have been distributed on the total weight of the production of the plant.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01 / 2003-12-31
Data Type	Derived, unspecified
Represents	Flows to and from nature for cradle to gate inventory of 1kg of iron oxide yellow colorant containing Bermodol SPS 2532
Method	LCI data from interviews with employees at the manufacturers of raw materials used in the production of colorants and with interviews with employees at the colorant manufacturer. Additional data has been taken from company internal publications at Akzo Nobel regarding the raw materials produced there. Calculations were carried out with the software tool Ecolab. Natural resources that can be used both as energy carriers and as material resources are accounted for in MJ regardless of whether the resource is used as an energy carrier or as a material resource.
Literature Reference	S. Bengtsson, L. Sjöberg; Study of environmental costs and environmental impacts in the chemical industry; Akzo Nobel/Chalmers University of Technology; 2004
Notes	The emissions for the combustion of the fuels are accounted for.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Resource	Biomass	0.0442			MJ	Ground	Europe

	Input	Resource	Coal	0.171			MJ	Ground	Europe
	Input	Resource	Crude oil	6.08			MJ	Ground	Europe
	Input	Resource	Hydro power	0.510			MJ	Ground	Europe
	Input	Resource	Iron oxide	526			g	Ground	Germany
	Input	Resource	Natural gas	5.52			MJ	Ground	Europe
	Input	Resource	Nuclear energy	1.16			MJ	Ground	Europe
Notes: Contributions to the total emissions of CO by the manufacture of the different raw materials and by transports to the Colorant Manufacturer. Emissions caused by the production of all necessary raw materials are included in the data for Bermodol SPS 2532, polyethyleneglycol and Pigment. Transports: 16% of the total CO emissions Bermodol SPS 2532: 75% Polyethyleneglycol: 9% Pigment: 0%	Output	Emission	CO	0.140			g	Air	
Notes: Contributions to the total emissions of CO2 by the manufacture of the different raw materials and by transports to the Colorant Manufacturer. Emissions caused by the production of all necessary raw materials are included in the data for Bermodol SPS 2532, Polyethyleneglycol and Pigment. Transports: 7% of the total CO2 emissions Bermodol SPS 2532: 75% Polyethyleneglycol: 10% Pigment: 8%	Output	Emission	CO2	293			g	Air	
Notes: Contributions to the total emissions of HC by the manufacture of the different raw materials and by transports to the Colorant Manufacturer. Emissions caused by the production of all necessary raw materials are included in the data for Bermodol SPS 2532, polyethyleneglycol and pigment. Transports: 2% of the total HC emissions Bermodol SPS 2532: 84% Polyethyleneglycol: 13% Pigment: 1%	Output	Emission	HC	0.504			g	Air	
Notes: Contributions to the total emissions of NOx by the manufacture of the different raw materials and by transports to the Colorant Manufacturer. Emissions caused by the production of all necessary raw materials are included in the data for Bermodol 09, polyethyleneglycol and pigment. Transports: 15% of the total NOx emissions Bermodol SPS 2532: 66% Polyethyleneglycol: 8% Pigment: 11%	Output	Emission	NOx	1.35			g	Air	
	Output	Emission	Particles	0.151			g	Air	
Notes: Contributions to the total emissions of SO2 by the manufacture of the different raw materials and by transports to the Colorant Manufacturer. Emissions caused by the production of all necessary raw materials are included in the data for Bermodol SPS 2532, Polyethyleneglycol and Pigment. Transports: 1% of the total SO2 emissions Bermodol SPS 2532: 8% Polyethyleneglycol: 76% Pigment: 15%	Output	Emission	SO2	0.899			g	Air	
	Output	Product	Iron oxide yellow colorant containing Be	1000			g	Technosphere	

About Inventory

Publication	S.Bengtsson, L. Sjöborg, Study of environmental costs and environmental impacts in the chemical industry -- Data documented by:. Stefan Bengtsson, M Sc. student at Chalmers University of Technology and Akzo Nobel. Documentation reviewed by: Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology Published in SPINE@CPM: May 2004
Intended User	Akzo Nobel Surface Chemistry,

General Purpose	The LCA is performed to be used together with a study of environmental costs on the same system, to allow comparisons between environmental costs and environmental impacts in chemical industry.
Detailed Purpose	- Compare environmental impact caused by this colorant with environmental impacts of the colorant that this colorant was developed as an environmentally favourable alternative to - To track down the steps in the lifecycle with the largest environmental impacts
Commissioner	Akzo Nobel Surface Chemistry - .
Practitioner	Stefan Bengtsson and Li Sjöborg Akzo Nobel Surface Chemistry - .
Reviewer	Molander, Sverker, Chalmers University of Technology departm -
Applicability	Swedish production of iron oxide yellow colorants containing nonyl phenol ethoxylates. Since neither pigment nor transports affect the results very much the results could be used for colorants using other pigments produced elsewhere. The largest contribution to the environmental impact is caused by the production of Bermodol SPS 2532. The data should be usable for colorants with similar compositions as the studied colorant.
About Data	All production data have been obtained from technicians or sales managers of the different companies involved. Discussions with technicians have been more extensive for the raw materials produced at Akzo Nobel than for other raw materials. Electricity data is based on the electricity profile of the country in question. (1995 electricity profile). Data for transports in Sweden are average data for long distance transports in Sweden for trucks produced 1995 or later, with catalysts. For transports outside of Sweden average data for older trucks without catalysts is used. A large part of environmental impact data is based on environmental reports.
Notes	

SPINE LCI dataset: Production of iron oxide yellow colorant containing Berol 09

Administrative	
Finished	Y
Date Completed	2004-04-01
Copyright	
Availability	Public

Technical System	
Name	Production of iron oxide yellow colorant containing Berol 09
Functional Unit	1 kg
Functional Unit Explanation	Since the amount of colorant used depend on the specific color the customer wants it's not possible to use ''enough colorant to paint a square meter of wall'' without also specifying a specific shade of iron oxide yellow. Therefore 1 kg is used instead. To give an idea of the magnitude of the Functional unit: A couple of drops of colorant are normally used in a can of paint.
Process Type	Cradle to gate
Site	Sweden
Sector	
Owner	Sweden

Technical system description	Production of colorant. Colorant is produced by mixing monoethylene glycol, iron oxide yellow pigment, water and Berol 09. The plant is located in Sweden. Monoethylene glycol and Berol 09 is received from Akzo Nobel in Stenungsund, Sweden. The pigment is produced in Germany. Local water is used and the use of water is assumed to cause no environmental impacts. In general all flows are followed from the cradle (nature). The energy and material resources are traced back to the extraction of natural resources. National electricity grids have been used when the specific electricity supplier is unknown. The following are the most important systems included: 1. At the colorant manufacturer For 1kg of colorant these are the material requirements: Pigment 0,52kg Monoethylene glycol 0,26kg Water 0,12kg Berol 09 0,08kg The production of the colorant is a simple mixing of the ingredients and according to the manufacturer it causes no emissions and uses very little energy. 1.1. Monoethylene Glycol The monoethylene glycol inventory includes cradle to gate data for the raw materials needed (primarily ethylene oxide) and for the Heat consumed in the processes. All important transports are also included in the inventory 1.2. Pigment Since data from the pigment manufacturer in Germany could not be used, cradle to gate data for production of iron oxide in Sweden is used instead. 1.3 Berol 09 The Berol 09 inventory includes cradle to gate data for the raw materials needed and for the steam that is used in the process. All important transports are also included in the inventory. For one of the main raw materials, nonyl phenol, data from Akzo Nobel's Nonyl Phenol plant in Mölndal, Sweden is used instead of data from the current provider. Since the study is cradle to gate, the data in the flow table are the emissions and the resource use needed to manufacture: The colorant, all the raw materials needed to produce the colorant, and so on all the way back to the extraction of natural resources from the cradle (nature). Many of the raw materials (Glycol and Berol 09) are petrochemical and oil is used both as an energy carrier and as the main component of petrochemical materials. Oil use is accounted for in MJ regardless whether it's used as an energy carrier or not.

System Boundaries

Nature Boundary	No emissions from the colorant manufacturer are included since they are not measured. Different environmental impacts depending on the geographical location of the emission have not been considered. All material flows of the same substance are added together, regardless of where they originate.
Time Boundary	Data is chosen to model the production of colorant in 2003 as accurately as possible except for emission data from the production of nonyl phenol, a raw material of Berol 09, where data from the Akzo Nobel site in Mölndal from 1998 is used instead of data from the current supplier of nonyl phenol.
Geographical Boundary	The production of colorant and most of the raw materials are located in Sweden. The pigment is produced in Germany.
Other Boundaries	Environmental impacts caused by the production of machines, production plants and infrastructure is not included, neither is the environmental impact caused by the employees involved in the manufacture of the colorant and its raw materials. Only emissions and resource use that are considered to be relevant from an environmental point of view are included. Thus the use of air and water as natural resources is not included. Compounds that are emitted or used in small amounts compared to their environmental hazardousness or scarcity are also excluded from the inventory. All major transports are included. Emission data from transports in Sweden is based on simulations conducted by Volvo trucks and Scania in 1997. Transports in Europe is based on supplied values for Euro II engine with ECL-diesel. The emission and resource use data for environmental class 1 diesel has been taken from a life cycle inventory of the vehicle fuels presented by the Swedish transport and communications research board (KFB)

Allocations	Allocations have been done exclusively on mass basis. For example, when emission data from environmental reports, or data that covers the emission from an entire production plant the emissions have been distributed on the total weight of the production of the plant.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01 / 2003-12-31
Data Type	Derived, unspecified
Represents	Flows to and from nature for cradle to gate inventory of 1kg of iron oxide yellow colorant containing Berol 09
Method	LCI data from interviews with employees at the manufacturers of raw materials used in the production of colorants and with interviews with employees at the colorant manufacturer. Additional data has been taken from company internal publications at Akzo Nobel regarding the raw materials produced there. Calculations were carried out with the software tool Ecolab. Natural resources that can be used both as energy carriers and as material resources are accounted for in MJ regardless of whether the resource is used as an energy carrier or as a material resource.
Literature Reference	S. Bengtsson, L. Sjöborg; Study of environmental costs and environmental impacts in the chemical industry; Akzo Nobel/Chalmers University of Technology; 2004
Notes	The emissions for the combustion of the fuels are accounted for.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Resource	Biomass	0.071			MJ	Ground	Europe
	Input	Resource	Coal	0.220			MJ	Ground	Europe
	Input	Resource	Crude oil	10.4			MJ	Ground	Europe
	Input	Resource	Hydro power	0.724			MJ	Ground	Europe
	Input	Resource	Iron oxide	519			g	Ground	
	Input	Resource	Natural gas	8.87			MJ	Ground	Europe
	Input	Resource	Nuclear energy	1.69			MJ	Ground	
Notes: Contributions to the total emissions of CO by the manufacture of the different raw materials and by transports to the Colorant Manufacturer. Emissions caused by the production of all necessary raw materials are included in the data for Berol 09, Monoethylene glycol and Pigment. Transports: 12% of the total CO emissions Berol 09: 33% Monoethylene glycol: 55% Pigment: 0%	Output	Emission	CO	0.178			g	Air	Europe
Notes: Contributions to the total emissions of CO2 by the manufacture of the different raw materials and by transports to the Colorant Manufacturer. Emissions caused by the production of all necessary raw materials are included in the data for Berol 09, Monoethylene glycol and Pigment. Transports: 5% of the total CO2 emissions Berol 09: 29% Monoethylene glycol: 61% Pigment: 5%	Output	Emission	CO2	423			g	Air	
Notes: Contributions to the total emissions of HC by the manufacture of the different raw materials and by transports to the Colorant Manufacturer. Emissions caused by the production of all necessary raw materials are included in the data for Berol 09, Monoethylene glycol and Pigment. Transports: 1% of the total HC emissions Berol 09: 34% Monoethylene glycol: 65% Pigment: 0%	Output	Emission	HC	1.57			g	Air	Europe
Notes: Contributions to the total emissions of NOx by the manufacture of the different raw materials and by transports to the Colorant Manufacturer. Emissions caused by the production of all necessary raw materials are included in the data for Berol 09, Monoethylene glycol and Pigment. Transports: 12% of the total NOx emissions Berol 09: 26%	Output	Emission	NOx	1.64			g	Air	Europe

Monoethylene glycol: 53% Pigment: 9%									
	Output	Emission	Particles	0.133			g	Air	Europe
Notes: Contributions to the total emissions of SO_2 by the manufacture of the different raw materials and by transports to the Colorant Manufacturer. Emissions caused by the production of all necessary raw materials are included in the data for Berol 09, Monoethylene glycol and Pigment. Transports: 1% of the total SO_2 emissions Berol 09: 31% Monoethylene glycol: 56% Pigment: 12%	Output	Emission	SO_2	1.09			g	Air	Europe
	Output	Product	Iron oxide yellow colorant containing Be	1000			g	technosphere	

About Inventory

Publication	S.Bengtsson, L. Sjöborg, Study of environmental costs and environmental impacts in the chemical industry -- Data documented by:. Stefan Bengtsson, M Sc. student at Chalmers University of Technology and Akzo Nobel. Documentation reviewed by: Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM: May 2004
Intended User	Akzo Nobel Surface Chemistry,
General Purpose	The LCA is performed to be used together with a study of environmental costs on the same system, to allow comparisons between environmental costs and environmental impacts in chemical industry.
Detailed Purpose	- Compare environmental impact caused by this colorant with environmental impacts of a colorant that was developed as an environmentally favorable alternative to this colorant. - To track down the steps in the lifecycle with the largest environmental impacts.
Commissioner	Akzo Nobel Surface Chemistry - .
Practitioner	Stefan Bengtsson and Li Sjöborg Akzo Nobel Surface Chemistry - .
Reviewer	Molander, Sverker, Chalmers University of Technology departm -
Applicability	Swedish production of iron oxide yellow colorants containing nonyl phenol ethoxylates. Since neither pigment nor transports affect the results very much the results could be used for colorants using other pigments produced elsewhere. The largest contribution to the environmental impact is caused by the production of monoethylene glycol. The data should be usable for colorants with similar compositions as the studied colorant.
About Data	All production data have been obtained from technicians or sales managers of the different companies involved. Discussions with technicians have been more extensive for the raw materials produced at Akzo Nobel than for other raw materials. Electricity data is based on the electricity profile of the country in question. (1995 electricity profile). Data for transports in Sweden are average data for long distance transports in Sweden for trucks produced 1995 or later, with catalysts. For transports outside of Sweden average data for older trucks without catalysts is used. A large part of environmental impact data is based on environmental reports.
Notes	The report on environmental impacts and costs in the chemical industry is the result of a thesis project carried out in co-operation with Akzo Nobel Surface Chemistry and Chalmers University of Technology. Sverker Molander who is mentioned as reviewer of the study is the examiner of the final thesis. The final thesis report contains a study of environmental costs caused by the production of two colorants as well as a cradle to gate LCA of the same two colorants of which the colorant dealt with here is one.

SPINE LCI dataset: Production of Iron Powder

Administrative	
Finished	Y
Date Completed	2000-01-24
Copyright	
Availability	Public

Technical System	
Name	Production of Iron Powder
Functional Unit	1028.81 g of produced iron powder (PNC-30), with zink stearate (0.8%) as lubricant.
Functional Unit Explanation	The product name of the powder is PNC-30 and it's produced with the iron sponge process. In the original data set the lubricant, zink stearate, and Ferrophosphorus was not included.The easiest way to include it was simply to add it to the other inputs and then of course include it in the functional unit. This is the reason for the uneven number of grams.
Process Type	Cradle to gate
Site	Höganäs AB 26383 Höganäs Sweden
Sector	Materials and components
Owner	Höganäs AB 26383 Höganäs Sweden
Technical system description	This data set includes raw material aqcuisation, transports and production. The raw materials are: virgin iron, coal (coke), antracite and limestone. Höganäs AB buys the raw material from suppliers and the material is transported to the Höganäs AB plant in Höganäs where the production of the iron powder takes place. More specific data on the raw materials can not be given for secrecy reasons. At the plant in Höganäs the production can be divided in these steps: 1. Iron ore concentrate, Coke, Antracite and lime are dried and screened 2. Packing 3. Reduction -tunnel furnace 4. Emptying 5. Crushing/Grinding 6. Storing 7. Grinding 8. Screening 9. Equalizing 10. Full annealing 11. Crushing/Grinding 12. Screening 13. Equalizing 14. Packing 15. Weighting 16. Mixing -in this step the lubricant is added 17. Screening 18. Equalizing 19. Packing The iron powder is produced through the iron sponge process.

System Boundaries	
Nature Boundary	Main emissions to air and water are considered from cradle to gate.
Time Boundary	The data are based on the production in 1996.
Geographical Boundary	The plant is located in Höganäs, Sweden but it is not specified where the raw material is aqcuisated.
Other Boundaries	Subsystems concearning employees are not included. Resuorces not traced back to the cradle are: - Aluminium - Bricks - Cast Compound - Ceramics - Emulsifying agent - H2SO4 - Lime - Na2SO4

	- Solvey soda - Zink stearate
Allocations	not known
Systems Expansions	not known

Flow Data

General Activity QMetaData

Date Conceived	1996-01-01
Data Type	Unspecified
Represents	Flows to and from nature for cradle to gate inventory of 1kg of iron oxide yellow colorant containing Berol 09
Method	These data have been calculated by Katarina Edlund at Höganäs AB in Höganäs. No information about the calculation is available due to company secrecy.
Literature Reference	Höganäs AB internal information system.
Notes	All this data are taken from the same data base. Details about the data are noted if known.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Aluminium	1.11			mg	Ground	Sweden
	Input	Natural resource	Anthracite	3.397			g	Ground	Sweden
Notes: feedstock	Input	Natural resource	Anthracite, feedstock	982.078			g	Ground	Sweden
	Input	Natural resource	Bauxite	2.72E-8			g	Ground	Sweden
	Input	Natural resource	Bentonite	1.64E-3			g	Ground	Sweden
	Input	Natural resource	Bentonite	5.341			g	Ground	Sweden
	Input	Natural resource	Biomass	2.988			g	Forestral ground	Sweden
Date concieved: 1996-01-01 Notes: feedstock	Input	Natural resource	Biomass, feedstock	1.54E-4			g	Forestral ground	Sweden
	Input	Natural resource	Brown coal	9.479			g	Ground	Sweden
	Input	Natural resource	CaCO3	1.97E-3			g	Ground	Sweden
	Input	Natural resource	Caliche	1.399			g	Ground	Sweden
	Input	Natural resource	Clay	4.18E-4			g	Ground	Sweden
	Input	Natural resource	Coal	1.82E-2			g	Ground	Sweden
Notes: Copper ore 0.35%	Input	Natural resource	Copper Ore, 0.35% Cu	4.74E-5			g	Ground	Sweden
Notes: copper ore: 0.7% Cu	Input	Natural resource	Copper Ore, 0.7% Cu	0.338			g	Ground	Sweden
	Input	Natural resource	Crude oil	54.601			g	Ground	Sweden
Notes: feedstock	Input	Natural resource	Crude Oil, feedstock	9.90E-5			g	Ground	Sweden
	Input	Natural resource	Dolomite	1.65			mg	Ground	Sweden
Notes: unspecified fuel	Input	Natural resource	Energyware	3.26E-6			MJ	Ground	Sweden
	Input	Natural resource	Fe	1.17			mg	Ground	Sweden
	Input	Natural resource	Fe3P	20.58			g	Ground	Sweden
	Input	Natural resource	Feldspar	1.21			mg	Ground	Sweden
	Input	Natural resource	Ground water	2.64E-5			g	Ground water	Sweden
Notes: Hydropower in the unit MJelectricity.	Input	Natural resource	Hydro power	0.578			MJ	Water	Sweden

	Input	Natural resource	Iron ore	1.76			kg	Ground	Sweden
Notes: Lead ore: 1% Pb	Input	Natural resource	Lead ore	4.21E-3			g	Ground	Sweden
	Input	Natural resource	Lead ore	4.80E-6			g	Ground	Sweden
	Input	Natural resource	Limestone	102.660			g	Ground	Sweden
	Input	Natural resource	Manganese	6.92E-6			g	Ground	Sweden
	Input	Natural resource	Na2CO3	1.93			mg	Ground	Sweden
	Input	Natural resource	Natural gas	108.443			g	Ground	Sweden
	Input	Natural resource	Natural sand	1.34E-2			g	Ground	Sweden
	Input	Natural resource	O2	0.184			g	Air	Sweden
	Input	Natural resource	Olivine	38.356			g	Ground	Sweden
	Input	Natural resource	Peat	2.06E-4			g	Ground	Sweden
	Input	Natural resource	Sea water	0.522			g	Ocean	Sweden
	Input	Natural resource	Softwood	0.306			g	Forestral ground	Sweden
Notes: Water used for hydropower.	Input	Natural resource	Surface water	333.456			g	River	Sweden
	Input	Natural resource	Surface water	5.40E-7			g	Surface water	Sweden
	Input	Natural resource	Uranium	5.03E-3			g	Ground	Sweden
	Input	Natural resource	Uranium ore	1.90E-4			g	Ground	Sweden
	Input	Natural resource	Water	210			kg	Water	Sweden
Notes: MJ(electricity)	Input	Natural resource	Wind	1.23E-3			MJ	Air	Sweden
	Input	Natural resource	Wood	1.59E-2			g	Forestral ground	Sweden
Notes: Aluminium powder. Inflow not traced back to the cradle.	Input	Refined resource	Aluminium Powder	2.66E-2			g	Technosphere	Sweden
Notes: Inflow not traced back to the cradle.	Input	Refined resource	Brick	3.236			g	Technosphere	Sweden
Notes: Inflow not traced back to the cradle.	Input	Refined resource	Cast compound	8.630			g	Technosphere	Sweden
Notes: Inflow not traced back to the cradle.	Input	Refined resource	Ceramic	7.551			g	Technosphere	Sweden
Notes: Inflow not traced back to the cradle.	Input	Refined resource	Emulsifying agent	9.17E-3			g	Technosphere	Sweden
Notes: Inflow not traced back to the cradle.	Input	Refined resource	H2SO4	2.64E-2			g	Technosphere	Sweden
Notes: Inflow not traced back to the cradle.	Input	Refined resource	Lime	1.59E-2			g	Technosphere	Sweden
	Input	Refined resource	LPG	2.55E-4			g	Technosphere	Sweden
Notes: Inflow not traced back to the cradle.	Input	Refined resource	Na2SO4	9.94E-5			g	Technosphere	Sweden
	Input	Refined resource	NaCl	1.97			mg	Technosphere	Sweden
Notes: Inflow not traced back to the cradle.	Input	Refined resource	Solvey soda	1.93E-3			g	Technosphere	Sweden
Notes: Inflow not traced back to the cradle.	Input	Refined resource	Zinc stearate	8.23			g	Technosphere	Sweden
	Output	By-product	Pig iron	19.573			g	Technosphere	Sweden
	Output	Emission	Acetylene	7.60E-6			g	Air	Sweden
Notes: H+	Output	Emission	Acidification eq	1.71E-3			g	Water	Sweden
	Output	Emission	Al	1.16E-3			g	Water	Sweden
	Output	Emission	Aldehydes	2.16E-5			g	Air	Sweden
	Output	Emission	Alkanes	2.19E-4			g	Air	Sweden
	Output	Emission	Alkenes	1.67E-5			g	Air	Sweden
Notes: C9-C10	Output	Emission	Aromatics	3.30E-4			g	Air	Sweden

Notes: (C9-C10)	Output	Emission	Aromatics	9.59E-5			g	Water	Sweden
	Output	Emission	As	4.33E-6			g	Water	Sweden
	Output	Emission	As	5.64E-5			g	Air	Sweden
	Output	Emission	Benzene	2.87E-4			g	Air	Sweden
Notes: Outflow not followed to the grave.	Output	Emission	Benzene	5.382			g	Other	Sweden
	Output	Emission	Benzo(a)pyrene	2.55E-8			g	Air	Sweden
	Output	Emission	BOD	1.435E-4			g	Water	Sweden
	Output	Emission	Butane	1.58E-6			g	Air	Sweden
	Output	Emission	Ca	3.79E-6			g	Air	Sweden
	Output	Emission	Cd	1.56E-6			g	Water	Sweden
	Output	Emission	Cd	3.54E-5			g	Air	Sweden
	Output	Emission	CH4	9.508			g	Air	Sweden
	Output	Emission	Cl-	10.783			g	Water	Sweden
	Output	Emission	CO	1.977			g	Air	Sweden
	Output	Emission	Co	3.25E-4			g	Water	Sweden
	Output	Emission	Co	6.46E-6			g	Air	Sweden
	Output	Emission	CO2	2.10			kg	Air	Sweden
	Output	Emission	COD	3.10E-6			g	Air	Sweden
	Output	Emission	COD	3.49E-2			g	Water	Sweden
	Output	Emission	Cr	4.11E-4			g	Air	Sweden
	Output	Emission	Cr	4.45E-5			g	Water	Sweden
	Output	Emission	Cr3+	4.56E-7			g	Air	Sweden
	Output	Emission	Cr3+	8.16E-6			g	Water	Sweden
	Output	Emission	Cu	2.31E-4			g	Air	Sweden
	Output	Emission	Cu	8.73E-5			g	Water	Sweden
	Output	Emission	Dioxine	2.03E-10			g	Air	Sweden
	Output	Emission	Dissolved solids	0.584			g	Water	Sweden
	Output	Emission	Dissolved solids	64.7			mg	Air	Sweden
	Output	Emission	DOC	3.84E-12			g	Water	Sweden
	Output	Emission	Dust	5.31E-2			g	Air	Sweden
Notes: Outflow not followed to the grave.	Output	Emission	Dust	51.611			g	Other	Sweden
	Output	Emission	Ethane	1.51E-5			g	Air	Sweden
	Output	Emission	Ethene	3.81E-5			g	Air	Sweden
	Output	Emission	F-	1.87E-3			g	Water	Sweden
	Output	Emission	Fe	1.24E-2			g	Air	Sweden
	Output	Emission	Fe	1.30E-3			g	Water	Sweden
	Output	Emission	Fluoride	1.94E-4			g	Water	Sweden
	Output	Emission	Formaldehyde	2.61E-5			g	Air	Sweden
	Output	Emission	H2S	1.28E-7			g	Water	Sweden
	Output	Emission	H2S	5.10E-6			g	Air	Sweden
	Output	Emission	HC	2.80E-4			g	Water	Sweden
	Output	Emission	HC	6.13E-5			g	Air	Sweden
	Output	Emission	HCl	3.63E-2			g	Air	Sweden
	Output	Emission	HF	4.15E-2			g	Air	Sweden
	Output	Emission	Hg	2.05E-6			g	Air	Sweden
	Output	Emission	Metals	1.40E-5			g	Air	Sweden
	Output	Emission	Metals	6.98E-5			g	Water	Sweden
	Output	Emission	Mn	2.26E-4			g	Air	Sweden
	Output	Emission	Mn	2.56E-3			g	Water	Sweden
	Output	Emission	Mo	1.19E-4			g	Air	Sweden
	Output	Emission	N2O	4.24			mg	Air	Sweden
	Output	Emission	Na	3.55E-5			g	Air	Sweden
	Output	Emission	Na+	2.75E-5			g	Water	Sweden
	Output	Emission	NH3	1.17E-5			g	Water	Sweden
	Output	Emission	NH3	3.91E-4			g	Air	Sweden
	Output	Emission	NH4+	7.30E-3			g	Water	Sweden
	Output	Emission	NH4-N	4.45E-4			g	Air	Sweden
	Output	Emission	NH4-N	4.66E-4			g	Water	Sweden
	Output	Emission	Ni	2.24E-4			g	Air	Sweden
	Output	Emission	Ni	9.93E-5			g	Water	Sweden
	Output	Emission	Nitric acid	2.24E-5			g	Water	Sweden
	Output	Emission	NO2-	3.46E-4			g	Water	Sweden
	Output	Emission	NO3-	3.02E-3			g	Water	Sweden
	Output	Emission	NO3-N	3.60E-6			g	Water	Sweden

	Output	Emission	NOx	2.917			g	Air	Sweden
	Output	Emission	N-tot	2.12E-4			g	Water	Sweden
	Output	Emission	N-tot	3.96E-2			g	Water	Sweden
	Output	Emission	N-tot	5.38E-5			g	Air	Sweden
	Output	Emission	Oil	2.62E-2			g	Water	Sweden
	Output	Emission	Organic compounds	1.95E-2			g	Water	Sweden
	Output	Emission	Organic compounds	4.32E-5			g	Air	Sweden
	Output	Emission	PAH	4.02E-4			g	Air	Sweden
	Output	Emission	Particles	1.062			g	Air	Sweden
	Output	Emission	Pb	1.44E-4			g	Air	Sweden
	Output	Emission	Pb	3.10E-4			g	Water	Sweden
	Output	Emission	Pentane	2.70E-6			g	Air	Sweden
	Output	Emission	Phenol	1.05E-4			g	Water	Sweden
	Output	Emission	Phenol	1.51E-8			g	Air	Sweden
	Output	Emission	Phosphate	3.90E-5			g	Water	Sweden
	Output	Emission	PO43-	2.74E-5			g	Water	Sweden
	Output	Emission	Propane	2.47E-5			g	Air	Sweden
	Output	Emission	Propene	1.51E-5			g	Air	Sweden
	Output	Emission	P-tot	4.17E-4			g	Water	Sweden
	Output	Emission	Rock salt	5.82E-2			g	Water	Sweden
	Output	Emission	Sb	1.40E-8			g	Water	Sweden
	Output	Emission	Se	8.97E-7			g	Air	Sweden
	Output	Emission	Sn	1.10E-3			g	Water	Sweden
Date concieved: 1996-01-01 Data type: Unspecified Literature: Höganäs internal information system	Output	Emission	SO2	1.932			g	Air	Sweden
	Output	Emission	SO42-	0.439			g	Water	Sweden
	Output	Emission	Sr	3.24E-3			g	Water	Sweden
	Output	Emission	Susp solids	9.71E-4			g	Air	Sweden
	Output	Emission	TOC	4.75E-5			g	Water	Sweden
	Output	Emission	Toluene	9.48E-6			g	Air	Sweden
	Output	Emission	Tot-C	2.30E-3			g	Water	Sweden
	Output	Emission	Tot-CN	2.71E-6			g	Air	Sweden
	Output	Emission	Tot-CN	2.989E-4			g	Water	Sweden
	Output	Emission	V	1.82E-4			g	Air	Sweden
	Output	Emission	V	3.28E-6			g	Water	Sweden
	Output	Emission	VOC	0.1154			g	Air	Sweden
	Output	Emission	Zn	2.23E-4			g	Water	Sweden
	Output	Emission	Zn	4.25E-4			g	Air	Sweden
	Output	Product	Steel powder	1028.81			g	Technosphere	Sweden
	Output	Residue	Ashes	0.216			g	Technosphere	Sweden
	Output	Residue	Ashes	2.24E-4			g	Landfill ground	Sweden
	Output	Residue	Ashes	5.48E-8			g	Technosphere	Sweden
Notes: Outflow not followed to the grave.	Output	Residue	Brick	3.236			g	Technosphere	Sweden
	Output	Residue	Building waste	1.11E-2			g	Technosphere	Sweden
	Output	Residue	Bulky waste	315.699			g	Technosphere	Sweden
Notes: Outflow not followed to the grave.	Output	Residue	Ceramic	5.394			g	Technosphere	Sweden
Notes: Particulates seperated by filters.	Output	Residue	Dust	17.00			g	Technosphere	Sweden
	Output	Residue	Granite	807.767			g	Technosphere	Sweden
	Output	Residue	Hazardous waste	48.992			g	Technosphere	Sweden
	Output	Residue	Highly active rad ac waste	2.65E-2			g	Technosphere	Sweden
	Output	Residue	Industrial waste	284.198			g	Technosphere	Sweden
	Output	Residue	Low active rad ac waste	1.83E-12			m3	Technosphere	Sweden
	Output	Residue	Medium active rad ac waste	1.83E-12			m3	Technosphere	Sweden
	Output	Residue	Mineral waste	3.04E-2			g	Technosphere	Sweden
	Output	Residue	Other rest products	17.459			g	Technosphere	Sweden
	Output	Residue	Other rest products	4.43E-2			g	Technosphere	Sweden
	Output	Residue	Radioactive waste	1.87E-3			g	Technosphere	Sweden
	Output	Residue	Reject	17.260			g	Technosphere	Sweden
	Output	Residue	Rocks	6.21E-2			g	Technosphere	Sweden

	Output	Residue	Rubber	3.56E-4			g	Technosphere	Sweden
	Output	Residue	Slag	1.707			g	Technosphere	Sweden
Notes: Outflow not followed to the grave.	Output	Residue	Slag	115.728			g	Technosphere	Sweden
	Output	Residue	Sludge	8.514			g	Technosphere	Sweden
Notes: Outflow not followed to the grave.	Output	Residue	Sulphur	1.015			g	Technosphere	Sweden
Notes: Outflow not followed to the grave.	Output	Residue	Tar	18.615			g	Technosphere	Sweden
Notes: Outflow not followed to the grave.	Output	Residue	Tunnel furnace ashes	213.592			g	Technosphere	Sweden

About Inventory	
Publication	Master's thesis ''LCA on SKF's Spherical Roller Bearing 24024'' by Åsa Ekdahl, ESA-report 2001:1, Department of Environmental Systems Analysis (ESA), Chalmers University of Technology (ISSN 1400-9560) This report is available for download at ESAs web-site: http://www.esa.chalmers.se --- Data documented by: Åsa Ekdahl, M Sc. student at the dept. of Environmental Systems Analysis, Chalmers University of Technology and SKF Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 ---
Intended User	The intended users are LCA-pra
General Purpose	The general purpose is use within LCAs.
Detailed Purpose	The data are to be used in the study: ''LCA on SKF's Spherical Roller Bearing 24024''. The aim of the study is to descibe the environmental properties of the bearing as well as identify the processes contributing most to the environmental impact.
Commissioner	Patrik Lindroth - SKF Sverige AB SRB Medium D3s3 415 50 Göteborg .
Practitioner	Katarina Edlund - Höganäs AB 26383 Höganäs Sweden .
Reviewer	
Applicability	The data are applicable to PNC-30 iron powder, with zink stearate as lubricant (0.8%) produced by the iron spunge process.
About Data	The data has been calculated by Katarina Edlund in the software LCAiT and are based on a study performed at Höganäs in -97. Because of secrecy she has agreggated the data from the different processes within the cradle to gate process tree which in turn makes it impossible for me to evaluate the quality of the data.
Notes	Data has been collected and delivered by Katarina Edlund at Höganäs AB.

SPINE LCI dataset: Production of Kraftliner

Administrative	
Finished	Y
Date Completed	2000-01-18
Copyright	FEFCO, Groupement Ondulé, KRAFT Institute
Availability	The database is public and can be ordered from KRAFT Institu

Technical System	
Name	Production of Kraftliner
Functional Unit	One ton of net saleable produced Kraftliner
Functional Unit Explanation	Saleable means ready for delivery to customer.

Process Type	Gate to gate
Site	European average
Sector	Materials and components
Owner	European average
Technical system description	Kraftliner is a component used for manufacturing of corrugated board. The Kraftliner is manufactured in a paper mill. These data are taken from ''European Database for Corrugated Board - Life Cycle Studies'' published by FEFCO, Groupement Ondulé and KRAFT Institute. These are the most resent data and are based on the year 1996. There will be an update in the year 2000 in which the data will be based on 1999. Only the processes within the mill are included. That is no transports to or from the mill are included. The forestry processes are not included. The raw material for Kraftliner is wood, that is virgin fibres. Most of the wood is delivered to the mill in the form of pulpwood logs but a substantial part is brought to the mill as wood chips from saw mills. The pulpwood logs have to be debarked and chipped before further processing. Therefore logs pass through a barking drum and a chipper. The chips are then checked for oversized chips and other unwanted things. The oversized chips go through the chipper ones more. The chips are then stored in a chip pile before processing. The wood chips are cooked to pulp by the kraft cooking process. It is a highly alkaline cooking process with caustic soda and sodium-sulphide as active cooking chemicals. The cooking takes place in a digester at high pressure at a temperature of 150-170 degrees Celcius. The pulp yield is normally around 55% i.e. 1000 kg of dry wood gives 550 kg of pulp. The spent cooking liquor is drained off and washed out of the pulp. It contains wood substances as well as cooking chemicals. The liquor is concentrated and burnt for steam production and recovery of the cooking chemicals. The pulp is defiberized in refiners, screened and washed before being sent to the paper mill. The pulp is mechanical treated in beaters to improve fibre-to-fibre bonding and the strenght of the paper. The pH-level of the pulp slurry is adjusted with acid and some additives are added to facilitate the paper production. Finally the pulp slurry is screened and diluted before being sent to the head box of the paper machine. The paper is formed from the head box onto the wire and dewatered through the wire primarily by the action of gravity and suction.Further dewatering by mechanical means take place in the press section where water is taken out of the sheet by pressing between felts. The final drying takes place in the drying section of the machine where the sheets run against heated cylinders to get its final dryness of 92%. The collected water is reused. Kraftliner is normally a two ply product and therefor requires a paper machine with two head boxes and normally also two wires. The base brown ply contains recycled paper pulp and the internal machine broke pulp in addition to wood fibres from the integrated pulp production. The top ply is normally wood pulp from the integrated pulp production that is more refined and cleaner to give the top surface the right characteristics and printability. After the paper machine there is a slitter winder where the big jumbo reel from the paper machine is rewound and cut down to customer reel formats according to customer orders. Finally the reels are weighted, marked, labelled and prepared for shipment to the customer, the corrugated board industry.

System Boundaries

Nature Boundary	Emissions from fuel combustion outside the mill is not included in the data. Emissions to air from the sites have been reported. Emissions from incineration of rejects with energy recovery at the mill are included. Emissions in the steam of the paper mill are not included. Emissions to air originating from the use of biogas from the mills anaerobic wastewater treatment are included. Water that is taken in has to be treated before it is used in the process, and it is again treated after the process before it is released as effluent to a recipient. The substances in the effluent after wastewater treatment are reported.
Time Boundary	The data are from 1996 and are the most resent ones. In the year 2000 there will be an update of the database which will be based on the year 1999.
Geographical Boundary	The data are valid for production of Kraftliner in Europe, they do not represent a specific plant but are average data from many plants all over Europe. The mills produce 80% of the Kraftliner produced in Europe.
Other Boundaries	The production of raw material and resources is not included. The transportation of raw materials and residues is not included
Allocations	The system is considered as a closed loop system. This is not really true but is seen as a fairly good aproximation and is made in order to avoid allaocations. Within processes allocations has been made according to weight or according to the recipie for making the paper.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996-01-01
Data Type	Derived, statistics
Represents	European average
Method	The data are all taken from the Eropean Database for Corrugated Board-Life Cycle Studies
Literature Reference	Eropean Database for Corrugated Board-Life Cycle Studies
Notes	Average data for production of kraftliner in Europe.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Hardwood logs	Input	Natural resource	Hardwood	0.07			tonne	Forestral ground	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: softwood logs: 0,73 kg softwood chips: 0,48 Kg	Input	Natural resource	Softwood	1.21			tonne	Forestral ground	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	Al2(SO4)3	6.7			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Bark	650			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	biocides	0.08			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: packaging material	Input	Refined resource	Board	0.05			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	CaCO3	2.9			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	CaO	4.1			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Material unknown Used to wire the paper on.	Input	Refined resource	Core and core plug	1.91			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	Defoamers	0.95			kg	Technosphere	Europe

Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Diesel	30			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: This is bought electricity, not including the electricity produced at the plant.	Input	Refined resource	Electricity	2230			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	H2SO4	14.7			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Heavy oil	1690			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	Hydrochloric acid	0.07			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Light fuel oil	540			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	Lubricant	0.18			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Soda additive dry mass	Input	Refined resource	Na2CO3	1.9			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	Na2SO4	1.9			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	NaOH	9.3			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Natural gas	1040			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Peat	60			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	Pitch despergent	0.02			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	Retention aids	0.57			kg	Technosphere	Europe

Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	S	0.17			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	Sizing agents	1.6			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive dry mass	Input	Refined resource	Starch	4.2			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Packaging material	Input	Refined resource	Steel	0.05			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: recycled paper in two categories A: 0,19 ton D: 0,04 ton	Input	Refined resource	Waste paper	0.23			tonne	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: sold to the public grid	Output	By-product	Electricity	7			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: sold by-product	Output	By-product	Tall oil	25			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	By-product	Thermal energy	320			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: sold by-product	Output	By-product	Turpentine	1.3			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: BOD 5	Output	Emission	BOD	6.7			kg	Water	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: fosil: 220 kg biomass: 1360 kg	Output	Emission	CO2	1580			kg	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	COD	17.3			kg	Water	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	Dust	1.6			kg	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for	Output	Emission	H2S	0.14			kg	Air	Europe

Corrugated Board-Life Cycle Studies									
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Counted as NO2	Output	Emission	NOx	1.2			kg	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Counted as SO2	Output	Emission	SOx	0.86			kg	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	Susp solids	2.5			kg	Water	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Main product: Kraftliner	Output	Product	Kraftliner	1			tonne	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Residue	Ashes	4.3			kg	Landfill ground	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: this includes: inorganic sludge: 8,7 kg organic sludge: 3,5 kg paper related: 1,9 kg other rejects: 5,7 kg	Output	Residue	Other rest products	19.8			kg	Landfill ground	Europe

About Inventory	
Publication	Published in the report ''European Database for Corrugated Board-Life Cycle Studies'' by FEFCO, Groupement Ondulé and KRAFT Institute in 1997. -- Data documented by: Åsa Ekdahl, M Sc. student at the dept. of Environmental Systems Analysis, Chalmers University of Technology and SKF Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	The intended users are practit
General Purpose	The purpose is to provide the industry and its customers the up-to-date knowledge, based on facts concerning the impact of the industry on the environment. Through this database the industry aims to make a contribution to the increasing need for basic environmental data for LCA studies, available in a transparent way.
Detailed Purpose	This data set has been documented for use in the study: ''LCA on SKF's Spherical Roller Bearing 24024''. The aim of the study is to descibe the environmental properties of the bearing as well as identify the processes contributing most to the environmental impact.
Commissioner	KRAFT Institute - Norrtullsgatan 43 S- 113 45 Stockholm .
Practitioner	Manufacurers of Corrugated Board in Europe - .
Reviewer	
Applicability	The data can be used for the production of Kraftliner in Europe that follow the process steps presented under ''Function''. The data are average for plants in Europe and do not represent a specific plant. Data for the production of Semichemical fluting and a Corrugated board box from the ''European Database for Corrugated Board-Life Cycle Studies'' is also available in SPINE@CPM. These activites are named: - Production of Semichemical Fluting - Production of a Corrugated Board Box (182*62*182)
About Data	

Notes	The database will be updated during the year 2000 and will then contain data for the year 1999.

SPINE LCI dataset: Production of latex rubber

Administrative	
Finished	Y
Date Completed	1994-02-01
Copyright	None
Availability	Only CPM companies

Technical System	
Name	Production of latex rubber
Functional Unit	1 kg latex rubber
Functional Unit Explanation	
Process Type	Cradle to gate
Site	
Sector	Agriculture
Owner	
Technical system description	Brief description: Theoretical model for the growth and harvest of rubber in a Malaysian rubber plantation, with transport to Europe and refining of the raw rubber to latex elastics. Process description: The yield of the harvested rubber is set to 1 000 kg rubber/ha and year. The main problem for the rubber production is diseases, since the crop is highly susceptible at all stages of its development. In order to apply the pesticides and insecticides studies have found that the pesticides/insecticides together with a refined oil and a suitable emulsifier gives a good fogging effect. Following fungicides are preferably used: Tridemorph 0.5 kg/ha (against Odium SLF) Chlorothalonil 0.4 kg/ha (against Colletotrichum SLF) Copper Oxychloride 1,2 kg/ha (against Phytophtora Leaf Fall) (SLF = secondary leaf fall) To these formulations was added 20% diesel. The fog generator has a capacity of 100-150 ha/day. The insecticide Permethrin is also used. Amount 0.07 kg/ha (against Hemithea Costipunctata, Euproctis, Hyposidra Talaca, etc) It can be assumed that the main part of the work are made by hand, also to draw off the rubber. In Malaysia this type of production is often a family business, and a normal figure is that one family can handle approx. 5,7 ha rubber trees. The transport is assumed to be 20,000 km by boat, using bunker C oil. The enrgy consumption would be 0.2 MJ/tonkm, or in this case 4MJ/kg rubber. Latex industry: No specific recipe can be used due to confidentiality, so the assumptions for the refining process is only based on the use of rubber in the refining process. The yield from the process is rather bad, so there is a need for 40% more rubber than the result of latex elastics. It is assumed that the emissions connected to the process, except for the energy, are neglectable.

System Boundaries

Nature Boundary	Raw material consumption Energy consumption
Time Boundary	
Geographical Boundary	Malaysian rubber plantation, transport to Europe
Other Boundaries	Only trees that give a yield of rubber are taken into account, the growth from seed to tree is excluded. The rawmaterials for the biocides are not followed to their extraction.
Allocations	No allocations
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1994-02-01
Data Type	Derived, unspecified
Represents	European average
Method	Theoretical model, with assumptions from literature data
Literature Reference	''Effects of selected environmental and technological factors on rubber production - a case study of RRIM Economic Laboratory'', Mohd. Napi Daud, J. Nayagam, P. Veramuthoo, Rubber Research Institute of Malaysia. ''Pesticide application technology in perennial crops in Malaysia'', K.C. Khoo, T.K. Lim, Dept. of Plant Protection, University of Pertanian, Malaysia, C.T. Ho, Harrisons Malaysian Plantations, Berhad, Malaysia, K.Y. Ng, Agrochemicals division, Bayer, Malaysia. Unspecified latex industry, Europe BUWAL report 1991 NUTEK
Notes	Average data for production of kraftliner in Europe.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Chlorothanonil	0.45			g	Technosphere	
	Input	Refined resource	Copper Oxychloride	1.34			g	Technosphere	
	Input	Refined resource	Diesel	0.61			g	Technosphere	
	Input	Refined resource	Electricity	1			kWh	Technosphere	
	Input	Refined resource	Heavy oil	44			MJ	Technosphere	
	Input	Refined resource	Permetrin	0.08			g	Technosphere	
	Input	Refined resource	Raw rubber	1.40			kg	Agricultural ground	
	Input	Refined resource	Tridemorph	0.56			g	Technosphere	
	Output	Product	Latex rubber	1			kg	Technosphere	

About Inventory

Publication	Internal report at SCA Mölnlycke: ''The Rubber Model'', G. Brohammer. -- Data documented by: Ellen Riise, Mölnlycke AB Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	To be used in LCA studies, when data is missing
Detailed Purpose	
Commissioner	- SCA Mölnlycke AB, 405 03 Göteborg.
Practitioner	Brohammer, Göran - KM Miljöteknik AB, Rullagergatan 6, 415 26 Göteborg.
Reviewer	
Applicability	CERTAIN CAUTIONS: This study is very roughly made but could be seen as better than nothing.
About Data	GENERAL DATA SOURCE DESCRIPTION:
Notes	

SPINE LCI dataset: Production of Linear Alkylbenzene Sulphonates (LAS)

Administrative	
Finished	Y
Date Completed	1995-04-01
Copyright	Carl Hanser Verlag, München
Availability	Public

Technical System	
Name	Production of Linear Alkylbenzene Sulphonates (LAS)
Functional Unit	1000 kg
Functional Unit Explanation	All emissions, use of resources and energy consumption is based on 1000 kg of LAS.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	BRIEF DESCRIPTION: The main steps of LAS production are: Crude oil production: The study includes drilling, pumping and separation of crude oil from brine water and tank storage. Crude oil refining: The refining includes desalting, hydrotreating and distillation (fractionation/extraction of crude oil into paraffins, olefins, benzene and ethylene). Benzene production: Benzene is one of the products from crude oil refining. n-Paraffin production: Benzene is one of the products from crude oil refining. Sulphur production: Sulphur is used in the LAS production process. No details were given on sulphur production. Salt mining: Salt is used for the production of caustic soda. No details were given on salt mining. Caustic soda production: Caustic soda is used in the LAS production process. No details were given on the production of caustic soda. LAB production: In the process, linear alcyl benzene (LAB) is produced from benzene and n-paraffins. LAS production: The process includes sulphonisation and neutralisation of LAB from sulphur and caustic soda.. Information concerning all the subsystems described above: Transports are included in the system. The fuels for the transports and the fuels for the processes are traced back to the extraction of petrochemical raw materials and/or the extraction of bio fuels. The electricity data are based on the electricity profile for each country and the petrochemical and biomass raw materials for electricity production are traced back to the extraction process (same process as for fuel raw materials).

System Boundaries

Nature Boundary	All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The process data used pertain mainly to 1992, being yearly averages where possible. It is recognised that operating processes and conditions are constantly evolving.
Geographical Boundary	This study examined the surfactant production in Europe, notably manufacturing processes conducted in Belgium, France, Germany, Italy, the Netherlands, Spain and the United Kingdom.
Other Boundaries	The detergent formulation, use and final disposal of the surfactants were not covered. The environmental effects associated with the manufacture of capital equipment and with energy and fuel requirements for plant and building conditioning (heat, air etc.) were not included, neither were those associated with personnel requirements. For electricity based on nuclear power and wind power, no emissions and resource exploits have been accounted for.
Allocations	Raw materials, energy and environmental emissions are allocated among co-products on an output weight basis, i.e. on the basis of mass. Co-products in this LCI include those materials that are currently recycled, reused or marketed in some beneficial way.
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study)

Flow Data

General Activity QMetaData

Date Conceived	1992
Data Type	Derived, unspecified
Represents	European average
Method	LC- inventory. Data from tables 1 to 5 pages 124-127 in lit. ref.
Literature Reference	Tenside Surfactants Detergents; 32. Jahrgang 2/95; Carl Hanser Verlag; Munchen
Notes	The raw material data are given in ''kg'' and the energy data are given in ''MJ''. However, it is important to remember that the raw materials themselves have an energy content.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Energy resource. The thermal value of coal is 27 MJ/kg.	Input	Natural resource	Coal	4590			MJ	Ground	
Notes: Energy resource. The thermal value of crude oil is 42 MJ/kg.	Input	Natural resource	Crude oil	7686			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Crude oil	841			kg	Ground	
Notes: Energy resource. The thermal value of natural gas is 45 MJ/kg.	Input	Natural resource	Natural gas	7290			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Rock salt	99			kg	Ground	
Notes: Raw material.	Input	Natural resource	Sulphur	100			kg	Ground	
Represents: Electricity produced by hydro power. Notes: Source of energy	Input	Refined resource	Hydro power	430			MJ	Technosphere	
Represents: Electricity produced by nuclear power. Notes: Source of energy	Input	Refined resource	Nuclear	2290			MJ	Technosphere	
	Output	Emission	Acid	0.01			kg	Water	
	Output	Emission	Al	0.0011			kg	Water	
	Output	Emission	Aldehydes	0.012			kg	Air	
	Output	Emission	Ammonia	0.00083			kg	Air	
	Output	Emission	Ammonia	0.017			kg	Water	
	Output	Emission	BOD	0.48			kg	Water	
	Output	Emission	Chloride	1.32			kg	Water	
	Output	Emission	Chlorine	0.0078			kg	Air	
	Output	Emission	CO	0.76			kg	Air	
Notes: Fossil emissions of CO2. Non-fossil emissions of CO2 from the process do not exist.	Output	Emission	CO2	1613			kg	Air	
	Output	Emission	COD	1.33			kg	Water	

	Output	Emission	Cr	0.0044			kg	Water	
	Output	Emission	Dissolved solids	3.15			kg	Water	
	Output	Emission	Fe	0.0026			kg	Water	
	Output	Emission	Fluorides	0.016			kg	Water	
	Output	Emission	Fluorine	0.0077			kg	Air	
	Output	Emission	HC	0.014			kg	Water	
	Output	Emission	HC	13.5			kg	Air	
	Output	Emission	HCl	0.12			kg	Air	
	Output	Emission	HF	0.012			kg	Air	
	Output	Emission	Hg	0.00003			kg	Water	
	Output	Emission	Hg	3.2E-4			kg	Air	
	Output	Emission	Metal ion	0.0082			kg	Water	
	Output	Emission	Metals	0.0077			kg	Air	
	Output	Emission	Ni	0.0022			kg	Water	
	Output	Emission	NOx	12.4			kg	Air	
	Output	Emission	Odorous sulphurs/thiols	0.00000042			kg	Air	
	Output	Emission	Oil	0.039			kg	Water	
	Output	Emission	Other chemicals	0.064			kg	Water	
	Output	Emission	Other organics	0.075			kg	Air	
	Output	Emission	Particles	3.6			kg	Air	
	Output	Emission	Pb	0.000013			kg	Water	
	Output	Emission	Pb	6.2E-6			kg	Air	
	Output	Emission	Phenol	0.0086			kg	Water	
	Output	Emission	Phosphates	0.0016			kg	Water	
	Output	Emission	SOx	16.8			kg	Air	
	Output	Emission	Sulphates	1.27			kg	Water	
	Output	Emission	Sulphides	0.11			kg	Water	
	Output	Emission	Susp solids	0.35			kg	Water	
	Output	Emission	Zn	0.00081			kg	Water	
	Output	Product	Linear Alkylbenzene Sulphonates	1000			kg	Technosphere	
	Output	Residue	Solid waste	64.7			kg	Ground	

About Inventory

Publication	Tenside Surfactants Detergents 32 (1995) 2 Carl Hanser Verlag, München -- Data documented by: Malin Ericson, Akzo Nobel Surface Chemistry Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Manufacturers and users of sur
General Purpose	-To produce an authoritative and comprehensive Life Cycle Inventory for major surfactant production in Europe through a common approach in order to facilitate objectivity in surfactant assessments on environmental grounds. -To secure the best possible validation of data and broad acceptance of the methodology and conclusions by industry, regulatory authorities and academia, through assessment of the study by an appropriate expert review panel.
Detailed Purpose	-To establish an industry-wide inventory of the energy and emissions associated with the production of major surfactants in Western Europe under the conditions prevailing in 1992. -To bring together environmental data on the use of the main raw material sources - crude oil, natural gas, mineral, oleochemical, agricultural feedstock - for the processing pathways to the derived major surfactants. -To provide benchmarks for the processing steps of surfactant production against which individual producers can assess their own processes and identify opportunities for improvement. -To publish the results of the study and its conclusions in the open literature for access and reference by interested bodies.
Commissioner	- European LCI Surfactant Study Group (CEFIC/ECOSOL).
Practitioner	- Franklin Associates, Ltd. 4121 W. 83rd St., Suite 108 Prairie Village, KS 66208, USA.
Reviewer	Klöppfer, Prof. Dr. W. - C.A.U. Consultants Frankfurt, Germany

Applicability	LAS is an anionic surfactant and a predominant surfactant in commercial detergent preparations. The world LAS production in 1993 was nearly 2 million tonnes. It represents appproximately 1/3 of all the total surfactant production, excluding soap. Since its introduction on the market it has been the predominant surfactant in commercial detergent preparations, such as powders and liquids for textile, dish washing and industrial cleaners, mainly because of its compatibility and synergistic interactions with other ingredients. It is generally not possible to replace one surfactant type by another without changing other components of a preparation, or altering performance characteristics. Therefore, it is not in general meaningful to compare surfactants on a weight basis.
About Data	13 industrial companies participated in the project, including major surfactant manufacturers, raw material and intermediate suppliers, as well as surfactant users in Europe, some of whom are both manufacturers and users. Participating companies are BASF, Colgate-Palmolive, Condea, Enichem Augusta, Henkel, Hoechst, Hüls, ICI, Petresa, Procter & Gamble, Shell, Unilever and Wibarco. Process data were obtained directly from each company performing the process. These data were often proprietary. Therefore, technical process data from private corporations were collected from a minimum of three producers for each intermediate and surfactant type. The information is presented in the form of industry averages in order to preserve confidentiality. Fuel-related data for European countries were based on various governmental statistics and industry contacts (aggregated and provided by Dr. I. Bousted, The Open University, UK).
Notes	Data for other surfactants such as Alcohol sulphates (AS), Alcohol ethoxy sulphates (AES), soap, Secondary alkane sulphonates (SAS), Alcohol ethoxylates (AE) and Alkyl polyglucosides (APG) were given in the same study.

SPINE LCI dataset: Production of linoleum

Administrative	
Finished	Y
Date Completed	1994
Copyright	
Availability	

Technical System	
Name	Production of linoleum
Functional Unit	1 m2
Functional Unit Explanation	1m2 linoleum.
Process Type	Gate to gate
Site	Forbo plant at Krommenie Amsterdam
Sector	Materials and components
Owner	Forbo plant at Krommenie Amsterdam
Technical system description	Production of Linoleum Linseed oil is catalytically oxidised and polymerised with air in large tanks. This produces linoxyn, which is mixed with resin. The cement is then mixtured with powdered cork, powdered wood, powdered limestone and pigment (titanium dioxide). After the mixing process, a homogeneous linoleum mass is obtained, which is then converted into granules. The granules are fused to backing, made from jute, under pressure and heat. The still soft sheeting is hung up in long loops in drying rooms to mature further, and is left there for two to three weeks. The sheets are coated and the sheeting is trimmed and rolled and after packaging it is ready for sale. The production chain takes four to six weeks. Linoleum wastage (from trimming and similar processes) is recovered to more than 99% in the production process.

System Boundaries

Nature Boundary	Emissions to air are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	Energy and resource consumption are accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	Unspecified
Represents	European average
Method	The data are based on information from Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994.
Literature Reference	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994
Notes	The raw material data are given in ''kg'' and the energy data are given in ''MJ''. However, it is important to remember that the raw materials themselves have an energy content.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Used at cultivating and grinding. Emission factors for the electricity used are not accounted for.	Input	Refined resource	Electricity	6.5			MJ	Technosphere	
	Input	Refined resource	Jute	0.250			kg	Technosphere	
	Input	Refined resource	Linseed oil	0.536			kg	Technosphere	
Notes: Used at felling and drying. Emission factors from the combustion of the natural gas is not acounted for.	Input	Refined resource	Natural gas	15			MJ	Technosphere	
	Input	Refined resource	Powdered limestone	0.408			kg	Technosphere	
	Input	Refined resource	Powdered wood	0.701			kg	Technosphere	
	Input	Refined resource	Resin	0.179			kg	Technosphere	
	Input	Refined resource	Titanium dioxide	0.102			kg	Technosphere	
	Output	Emission	Dust	0.66			g	Air	
	Output	Emission	VOC	4.6			g	Air	
Notes: The energy content in linoleum is17,7MJ/kg. The weight of 1 m2 is 2,3 kg.	Output	Product	Linoleum	1			m2	Technosphere	

About Inventory

Publication	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994 -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi

General Purpose	Exercise material in LCA coarse given at Technical Environmental Planning at Chalmers University of Technology, Sweden.
Detailed Purpose	
Commissioner	
Practitioner	Jönsson Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden.
Reviewer	
Applicability	The data is out of date.
About Data	
Notes	

SPINE LCI dataset: Production of linseed oil

Administrative

Finished	Y
Date Completed	1994
Copyright	
Availability	

Technical System

Name	Production of linseed oil
Functional Unit	1 kg
Functional Unit Explanation	1kg linseed oil
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Production of linseed oil, include cultivation and threshing of lin. The linseed is crushed and the oil is extracted by pressing. Linseed produces approximately 35%oil and 65% linseed shells. Linseed cake is used as cattle feed.

System Boundaries

Nature Boundary	Arable land used are accounted for in the study. No emissions for the combustion of diesel is included.
Time Boundary	
Geographical Boundary	
Other Boundaries	Energy consumption and fertilizers used are accounted for.
Allocations	When producing linseed oil the co-product Linseed cake is also produced. This co-product has an economic value which periodically approches that of linseed oil.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	Unspecified
Represents	European average
Method	The data are based on information from Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994
Literature Reference	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994
Notes	The raw material data are given in ''kg'' and the energy data are given in ''MJ''. However, it is important to remember that the raw materials themselves have an energy content.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: The unit is m2 and year.	Input	Refined resource	Agricultural land	17			m2	Agricultural ground	
Notes: Linseed threshing. Emission factors for the combustion of diesel is not accounted for.	Input	Refined resource	Diesel	0.6			MJ	Technosphere	
Notes: Pressing of oil	Input	Refined resource	Electricity	0.5			MJ	Technosphere	
	Input	Refined resource	Nitrogen fertiliser	23			g	Technosphere	
Notes: Fertilizer production	Input	Refined resource	Oil	2.7			MJ	Technosphere	
	Input	Refined resource	Phosphorous fertiliser	28			g	Technosphere	
	Output	Product	Linseed cake	1.86			kg	Technosphere	
	Output	Product	Linseed oil	1			kg	Technosphere	

About Inventory

Publication	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994 -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Detailed Purpose	
Commissioner	
Practitioner	Jönsson Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden.
Reviewer	
Applicability	The data are valid for linseed oil production in countries like Argentina, Canada and USA. When using the data one must remember that emission factors for the combustion of diesel is not accounted for in this data set.
About Data	When producing lenseed oil the co-product Linseed cake is also produced. This co-product has an economic value which periodically approches that of linseed oil.
Notes	

SPINE LCI dataset: Production of linseed oil in Sweden

Administrative	
Finished	Y
Date Completed	1994
Copyright	
Availability	

Technical System	
Name	Production of linseed oil in Sweden
Functional Unit	1 kg
Functional Unit Explanation	1kg linseed oil
Process Type	Cradle to gate
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	Production of linseed oil, include cultivation and threshing of lin. The linseed is crushed and the oil is extracted by pressing. Linseed produces approximately 35%oil and 65% linseed shells. Linseed cake is used as cattle feed.

System Boundaries	
Nature Boundary	Arable land used are accounted for in the study. No emissions from combustion of fossil fuels are included
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	Energy consumption and fertilizers used are accounted for.
Allocations	When producing linseed oil the co-product Linseed cake is also produced. This co-product has an economic value which periodically approches that of linseed oil.
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1994
Data Type	Unspecified
Represents	European average
Method	The data are based on information from Tillman, A-M., H Baumann, E. Eriksson, and T. Ryden, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. and personal communication with Larsson S-E, National linseed adviser, Örebro, 1993.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Ryden, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. and personal communication with Larsson S-E, National linseed adviser, Örebro, 1993.
Notes	The raw material data are given in ''kg'' and the energy data are given in ''MJ''. However, it is important to remember that the raw materials themselves have an energy content.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Agricultural land	6.7			m2	Agricultural ground	

Notes: Linseed threshing Emission factors for the combustion of diesel is not accounted for.	Input	Refined resource	Diesel	2.2			MJ	Technosphere	
Notes: Pressing of oil.	Input	Refined resource	Electricity	4.4			MJ	Technosphere	
	Input	Refined resource	Nitrogen fertiliser	46			g	Technosphere	
Notes: Fertilizer production	Input	Refined resource	Oil	3.0			MJ	Technosphere	
	Input	Refined resource	Phosphorous fertiliser	16			g	Technosphere	
	Output	Product	Linseed cake	1.86			kg	Technosphere	
	Output	Product	Linseed oil	1			kg	Technosphere	

About Inventory	
Publication	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994 -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Detailed Purpose	
Commissioner	
Practitioner	Jönsson Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden.
Reviewer	
Applicability	The data are valid for linseed oil production in Sweden When using the data one must remember that emission factors for the combustion of diesel is not accounted for in this data set.
About Data	When producing lenseed oil the co-product Linseed cake is also produced. This co-product has an economic value which periodically approches that of linseed oil.
Notes	

SPINE LCI dataset: Production of low-density polyethylene

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	Public

Technical System	
Name	Production of low-density polyethylene
Functional Unit	1 kg
Functional Unit Explanation	1 kg LDPE.

Process Type	Gate to gate
Site	Neste Polyeten AB Neste Polyeten AB Stenungsund
Sector	Materials and components
Owner	Neste Polyeten AB Neste Polyeten AB Stenungsund
Technical system description	The system consists of production of low-density polyethylene (LDPE). The raw material used is ethylene, which is delivered to the site via pipeline. LDPE is polymerised at approx. 2300 bar and 300 deg. Celsius. Since the reaction occurs at such high pressures, there are relatively large diffuse emissions of hydrocarbons. The pressure is maintained by electrical-power driven pumps. The resulting LDPE is transferred to an extruder where pelletisation of the base resin takes place. The base resin is then modified in an intensive mixer, by the admixture of additives. The melted plastic material from the intensive mixer is converted into a pelletised product in subsequent extrusion and pelletising equipment.

System Boundaries

Nature Boundary	In the system only emissions to air and water are accounted for.
Time Boundary	
Geographical Boundary	
Other Boundaries	Raw material, the product and the energy consumption are accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1990
Data Type	Unspecified
Represents	European average
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992., where they have used data from the environmental report of Neste Polyeten AB in Stenungsund. Emission factors have been used for the calculation of the emissions from the burning of oil, apart from SO2 and NOx emissions, which have been measured.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992
Notes	The raw material data are given in ''kg'' and the energy data are given in ''MJ''. However, it is important to remember that the raw materials themselves have an energy content.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	6.578			MJ	Technosphere	
	Input	Refined resource	Ethylene	1.007			kg	Technosphere	Sweden
	Input	Refined resource	Thermal energy	2.190			MJ	Technosphere	
	Output	Emission	CFC	0.86			mg	Air	Sweden
Notes: The emission of CO2 are caused by flaring.	Output	Emission	CO2	8.0			g	Air	
Notes: Diffuse emissions and rejects.	Output	Emission	Ethylene	8.0			g	Air	
	Output	Emission	NOx	275			mg	Air	
	Output	Emission	Propylene	1.01			g	Air	
	Output	Emission	SO2	117			mg	Air	
	Output	Emission	TOC	25.5			mg	Water	
	Output	Product	LDPE	1			kg	Technosphere	
Notes: The oil waste is sent to SAKAB.	Output	Residue	Oil waste	0.40			g	Water	

About Inventory	
Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study concerning packaging and the environment.
Detailed Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data are valid for Swedish conditions at a specific plant, but can be used as an approximation to other countries and other plants. One should though be aware of the fact that the situation in other countries may be very different and depending on this one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. The emissions caused by the production of the energy used in the system are not accounted for.
About Data	
Notes	

SPINE LCI dataset: Production of lubricating oil

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Production of lubricating oil
Functional Unit	m3
Functional Unit Explanation	1 m3 produced lubricating oil.
Process Type	Gate to gate
Site	BP Smörjmedel AB Skarsvikshamnen 418 34 Göteborg Sweden
Sector	Materials and components
Owner	BP Smörjmedel AB Skarsvikshamnen 418 34 Göteborg Sweden

Technical system description	BP Smörjmedel AB, which belongs to the Preem combine, produces lubricating oil. A storage of basic oils and other additives are part of the production of lubricating oils. The finished products are stored outsidethe aria, except for a small amount, which is stored in tanks within the area. The company does not use products that causes emissions to air. Hot water is used as an energy source.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	Waste water, constituting drainage from hygiene and lavatory, is led to the local sewage treatment works. Waste water, constituting water from spillage plates and drainage from cisterns, is led to AB GRAAB Kemi to be cleaned. Surface water, which is not oil contaminated, is led trough a controlling plant, which is joint for the whole Preem combine, to the recipient. Waste from chemicals and lubricating oils is collected and in closed tanks and transported to AB GRAAB Kemi. The hazardous waste constituting waste from solvents and lubricating oils mm is disposed by AB GRAAB Kemi.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	European average
Method	Study the Environmental report The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1996.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992
Notes	The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1996 Data type: Unspecified Notes: 100% of the substance becames part of the product.	Input	Refined resource	Additives	0.123873874			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: 100% of the substance becames part of the product.	Input	Refined resource	Basic oil	0.867117117			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: 100% of the substance becames part of the product.	Input	Refined resource	Paraffin	0.009009009			m3	Technosphere	
	Output	Product	Lubricating oil	1			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consist of waste from lubricating oil and chemicals. The waste is disposed by Reci Industri AB.	Output	Residue	Hazardous waste	0.012927928			tonne	Technosphere	

About Inventory	
Publication	The environmental report from BP Smörjmedel AB for 1996, The Board of County in Göteborg and Bohus -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden.
Practitioner	Johansson, Fred - BP Smörjmedel AB Skarsvikshamnen 418 34 Göteborg Sweden.
Reviewer	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden
Applicability	The function of the technical system is not sufficently described. Contact the company to get the necessary details. To get sufficient information about the emissions to water to do a life cycle analyse see the environmental report from Preem Rarrinaderi, Göteborgsterminalen, Göteborgs Hamn AB and Reci Industri AB. The sewage system is the same for all companies at Skarvik and they have joint sewage treatment works. Reci Industri AB takes care of the rest products from the sewage treatment works. The total amount of the waste water from Skarvik (inkl Preem Rarrinaderi, Göteborgsterminalen and Göteborgs Hamn AB), constituting drainage from hygiene and lavatory, is led to the local sewage treatment works, Ryaverket. For more information see the environmental report from Preem Rarrinaderi, Göteborgsterminalen and Göteborgs Hamn AB. Waste water, constituting water from spillage plates and drainage from cisterns, is led through a local oil separater to AB GRAAB Kemi to be cleaned. For more information see the environmental report from Reci Industri AB, which disposes of the waste. For more information about the waste from the oil separater see the environmental report from Preem Rarrinaderi, Göteborgsterminalen and Göteborgs Hamn AB. Surface water, which is not oil contaminated, is led trough a controlling plant before it is let out in the recipient. For more information about the emissions to the recipient see the environmental report from Preem Rarrinaderi, Göteborgsterminalen and Göteborgs Hamn AB. Hot water is used as energy. The hot water is distributed by Göteborgs Hamn AB's furnace plant. The amount is not specified neither in kWh nor m3.
About Data	
Notes	

SPINE LCI dataset: Production of mastic

Administrative	
Finished	Y
Date Completed	2000-11-15
Copyright	The declaration does not say if there are any copyrights.
Availability	Public

Technical System

Name	Production of mastic
Functional Unit	1 kg of mastic.
Functional Unit Explanation	Mastic is used for air-tightening of ducts.
Process Type	Gate to gate
Site	Sweden
Sector	Manufacturing
Owner	Sweden
Technical system description	This documention describes production of mastic. Mastic is used for making products airtight.

System Boundaries

Nature Boundary	Emissions to air, water and soil are not included due to lack of data.
Time Boundary	The data was conceived 2000. There are no known time limitations when using this data.
Geographical Boundary	The raw materials are from Europe but the production of mastic is made in Sweden.
Other Boundaries	The extraction of acrylate dispersion is included. The energy demands is not included due to lack of information. Production of following refined resources: Diethyleneglycol dibenzoaten dipropyleneglycol dibenzoate and ethanol is not included.
Allocations	The environmental declaration does not say how the allocation is made when the industry produce more than one product.
Systems Expansions	Not relevant.

Flow Data

General Activity QMetaData

Date Conceived	2000-01-15--2000-11-30
Data Type	Derived, unspecified
Represents	Not relevant.
Method	The inventory data acquired from an environmental product declaration from Sika Sverige AB
Literature Reference	Environmental declaration, 2000-11-15, Sika Sverige AB, Box 6009, 175 06 Järfälla
Notes	Prepared for Ecolab by Annika Olsson. Checked by Malin Bogeskär.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Acrylic dispersion	300			g	Technosphere	Europe
	Input	Refined resource	Diethyleneglycol dibenzoate	30			g	Technosphere	Europe
	Input	Refined resource	Dipropyleneglycol dibenzoate	30			g	Technosphere	Europe
	Input	Refined resource	Ethanol	30			g	Technosphere	Europe
	Output	Product	Lime	600			g	Technosphere	Europe
	Output	Product	Mastic	1			kg	Technosphere	Europe

About Inventory

Publication	Environmental declaration, Sika Sverige AB, 2000-11-15 -- Data documented by: Annika Olsson, 2002-10-10 Documentation reviewed by: Karolina Flemström, IMI, Chalmers University of Technology Published in SPINE@CPM: 2002-12-10 --
Intended User	The intended user of this inve
General Purpose	The purpose is to inform interested parties the environmental impact of mastic.

Detailed Purpose	In this case the specific purpose is to use the inventory data for mastic in a master´s thesis: Life-cycle assessment of two ventilation systems, by Annika Olsson, Chalmers University of Technology, 2002.
Commissioner	Lindab Ventilation AB - - .
Practitioner	Annika Olsson - .
Reviewer	Malin Bogeskär -
Applicability	This data is from a specific company making mastic. The data is only applicable for this company. Mastic is UV-radiation and ozone resistant.
About Data	The environmental product declaration, this documention is based on, does not describe any methods for acquire numerical data. Certified according to ISO 9001 and 14001. Because the company follows the regulation from EU and the BYKR (Byggsektorns Kretsloppsråd) the data i the environmental declaration will be up-dated as soon as there are any changes. The data in this inventory are taking directly from the Product declaration of mastic performed by Sika Sverige AB.
Notes	

SPINE LCI dataset: Production of matte copper

Administrative	
Finished	Y
Date Completed	1998
Copyright	The International Copper Association
Availability	Public

Technical System	
Name	Production of matte copper
Functional Unit	1 kg of Matte Copper
Functional Unit Explanation	The copper content of matte according to published literature is between 40-75%.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	Data received for this study are based on pyrometallurgical operations only. This activity includes: 1) Copper ore mining; 2) Copper ore concentrate preparation and delivery; 3) Production of matte copper. Production and use of electricity and fuel used in the processes are included. Below is a description of the included operations. -- 1) Ore mining -- The copper ore mining method used is determined by the size, shape and depth below the surface of the ore body. Most copper ores are mined by open pit mining in which large quarries are opened, the ore broken away from the deposits by use of explosives and shovelled into trucks. Actual energy requirements vary widely depending on the characteristics of the mine and ore handling techniques used. The type and the amount of ore deposit and the overlying rock and dirt and the depth of the seam below the surface, affect the level of energy needed for mining the ore. The data for copper mining have been received from three mining companies. The data

	cover the mining of 45 million tonnes of ore. -- 2) Ore concentrate preparation and delivery -- It is normal practice for mining companies to prepare or concentrate before shipping to reduce the amount of material to be transported. The data mainly relates to transportation of ore concentrate by rail and sea. Transporting the concentrate by sea is exstensive. It is assumed that average shipping and rail transport distances were 10 000 km and 500 km respectively. The data cover preparation of 2 million tonnes of concentrate -- 3) Production of matte copper -- Here the ore concentrate, mixed with flux and other additives, is charged in a fuelfired smelting furnace where it is melted. The molten mass is allowed to separate into two layers. The upper slag layer, made up of iron silicate with less than 0,5% of copper, is normally discarded. The lower matte layer, with about 40% to 75% of copper, and containing most of original metal present, is transferred to the converting step to produce blister copper.

System Boundaries

Nature Boundary	Some of the data on air and water emissions was provided in a form which made it impractical to calculate emissions for unit mass of product output. For example, from an air emission value given in the units of mg/m3 of air, it is not possible to calculate the total emission unless the total volume of air is known and this is seldom measured in pactice.Therefor, where available, only emission values associated with the given amount of product made are used.
Time Boundary	The data comes from mining companies and producers of primary copper for the operations during the 12 month period in 1995 (information why the year 1995 was chosen is not available).
Geographical Boundary	The data comes mainly from European operations. Futher information of the geographical boundaries is not available.
Other Boundaries	The copper producing industry is international.
Allocations	The first thing that has been done to analyse this system is to break down the complex system into a series of separate sub-systems each of which produces a single product but which, when added together, exhibit the same charateristics as the original single system. In this study has co-product allocation and Stoichiometric allocation been applied. It is not often that practical processes exactly match for example the stoichiometric rules and an alternative method using mass must be applied.
Systems Expansions	Not applied

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, unspecified
Represents	Not relevant.
Method	An LCA calculation of matte copper production. The tables that have been used are the tables 43, 45, 46, 47 and 48 in the Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998. For the following subjects has a slightly different name been use here in SPINE compaired from the original tables in the IAC report: In SPINE: In the IAC report: Iron Ore Iron Natural Gas Gas/Condensate NaCl Sodium Chloride HC Hydrocarbons CH4 Methane Cu Cu++/Cu+++ Na Na+ Calcium Ca++ NO3-N NO3- Hazardous waste Regulated chemical
Literature Reference	Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998.
Notes	Prepared for Ecolab by Annika Olsson. Checked by Malin Bogeskär.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Bauxite	22000			mg	Ground	
	Input	Natural resource	Bentonite	55			mg	Ground	
	Input	Natural resource	Calcium sulphate	1200			mg	Ground	
	Input	Natural resource	Coal	918000			mg	Ground	
	Input	Natural resource	Crude oil	180000			mg	Ground	
	Input	Natural resource	Dolomite	910			mg	Ground	
	Input	Natural resource	Iron ore	74000			mg	Ground	
	Input	Natural resource	Lead	2			mg	Ground	
	Input	Natural resource	Lignite	18000			mg	Ground	
	Input	Natural resource	Limestone	70000			mg	Ground	
	Input	Natural resource	Natural gas	64000			mg	Ground	

	Input	Natural resource	Wood	49000			mg	Ground	
	Output	Emission	As	17			mg	Air	
	Output	Emission	BOD	540			mg	Water	
	Output	Emission	Calcium	370			mg	Water	
	Output	Emission	CH4	1100			mg	Air	
	Output	Emission	Cl	260000			mg	Water	
	Output	Emission	CO	5100			mg	Air	
	Output	Emission	CO2	3200000			mg	Air	
	Output	Emission	COD	1200			mg	Water	
	Output	Emission	Cu	10			mg	Water	
	Output	Emission	Cu	270			mg	Air	
	Output	Emission	Dissolved solids	580000			mg	Water	
	Output	Emission	HC	3000			mg	Air	
	Output	Emission	HCl	400			mg	Air	
	Output	Emission	HF	20			mg	Air	
	Output	Emission	NH4	23			mg	Water	
	Output	Emission	NO3-N	150			mg	Water	
	Output	Emission	NOx	27000			mg	Air	
	Output	Emission	Pb	1400			mg	Air	
	Output	Emission	Pb	20			mg	Water	
	Output	Emission	SO4	100000			mg	Water	
	Output	Emission	SOx	37000			mg	Air	
	Output	Emission	Sulphur	1000			mg	Water	
	Output	Emission	Susp solids	25000			mg	Water	
	Output	Emission	Zinc	50			mg	Air	
	Output	Product	Matte copper	1			kg	Technosphere	
	Output	Residue	Ashes	80000			mg	Technosphere	
	Output	Residue	Hazardous waste	6			mg	Technosphere	
	Output	Residue	Industrial waste	3900			mg	Technosphere	
	Output	Residue	Mineral waste	89000000			mg	Technosphere	

About Inventory

Publication	Ecoprofile of Primary Copper Production- A report for The International Copper Association By Dr. I. Boustead. 1998. -- Data documented by: Sofia Medin, Electrolux ESD Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose of this study was to produce life-cycle inventory data for the production of primary copper and the sub-processes based on data submitted by members of the International Copper Association from their own operations.
Detailed Purpose	The aim is to provide ''cradle to gate'' data for the production of matte copper, which is a sub-process in the production of primary copper.
Commissioner	- The International Copper Association .
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	There is no recommendation of how to use the data from this report. This activity is part of a ''cradle to gate'' system for primary copper production. In the sequence of operations leading up to primary copper production there are six main stages involved. These are 1) Copper ore mining; 2) Copper ore concentrate preparation and delivery; 3) Production of matte copper; 4) Production of blister copper; 5) Production of copper anodes and 6) Production of primary copper. This activity only covers the stages 1) copper ore mining and 2) copper ore concentrate preparation and delivery and 3) Production of matte copper. All six stages in the primary copper production have been described cumulatively in separate activities in the database.
About Data	The data used for electricity and fuel production in the calculations leading to the results reported comes from the reports of International Energy Agency. Data Assumptions: Data received from participating companies show sometime wide variation with respect to metal contents of ore and various intermediate products such as concentrates, gas dust and

	scrap. Therefor has the following assumptions been made: 1. Copper content in ore. Where actual data on copper content of the ore were available these were used. Otherwise the content was calculated on the basis of mass flow. 2. Copper content of matte according to published literature is between 40% to 75%. The assumption made, where the copper content in matte was not derived from mass flow, is therefor 60 %. 3. There is also some loss of copper during ore preperation and the smelting and recovery processes. The loss can be calculated from the mass flow if accurate contents of the input and output materials where known.Where this is not possible, the loss is assumed to be 1% at each step of the sequence of operations. It is further assumed that there is another 4% loss of copper during the operational steps from ore preperation to electro-refining, making the total loss of copper to 5%.
Notes	The results of the Ecoprofile study has been broken down into a number of categories, identifying the type of operation that gives rise to them. The categories are: 1. Fuel production 2. Fuel use 3. Process 4. Transport 5. Biomass (inputs and outputs associated with the use of biological materials such as wood)

SPINE LCI dataset: Production of Melamin-Urea-Formaldehyde resin 1241(MUF 1241), Wood Adhesive

Administrative	
Finished	Y
Date Completed	2003-03-21
Copyright	Casco Products
Availability	

Technical System	
Name	Production of Melamin-Urea-Formaldehyde resin 1241(MUF 1241), Wood Adhesive
Functional Unit	1 kg MUF 1241
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg MUF 1241. The wood adhesive is delivered with 65% dry content. The content of free formaldehyde is 0.6% Abbreviation: MUF= Melamine-Formaldehyde adhesive
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	MUF 1241 is produced by Casco Products in Kristinehamn. It is a mixture of an UF and a MF resin, celllulose filler, solvent and acrylate copolymer dispersion. Small amounts of sodium hydroxide and formic acid are used for pH adjustments. Additves are silcic acid for tixotrophy and defoamer. All ingredients except the cellulose filler, silicic acid and defoamer could be followed to the cradle. The packages were not included. The production of the UF and MF resins and formaldehyde takes place at the same site in Kristinehamn. Sodium hydroxide is manufactured in Sweden and transported a short distance by truck, while the main raw materials urea, melamine and methanol are produced in different parts of Europe. Urea and methanol are transported by sea as bulk transports and melamine by truck, most of it in Big Bags. The processes use steam which is produced on site from oil and electricty form the net. The main steps of MUF 1241 production are:

	1. Natural gas production: The study includes winning, delivery to shore and storage. Natural gas is used in the production of methanol and ammonia. 2. Methanol production: Natural gas is produced into synthesis gas in reformers. Synthesis gas is converted to raw methanol in a catalytic process and distilled into finished methanol. Storage is included. 3. Formalin production: Formalin is produced from methanol by oxidation in the Formox process. The process is exothermic and produces steam, which is utilised in the plant. 4. Ammonia and urea production: Ammonia is produced from natural gas, air and water in a steam reforming process. In the process carbon dioxide is produced. The urea plant is situated on the same site as the ammonia plant. Urea is produced by reacting ammonia and carbon dioxide at 150 bar at an operation temparature of 185-190°C. The carbon dioxide used in the urea process comes from the ammonia process. Excess carbon dioxide is accounted for as emission to air. 4. Formic acid is produced from sodium formate and sulphuric acid with sodium sulphate as a by-product. 5. Sodium hydroxide is produced from soduim chloride in an electrolytic reaction. 6. UF resin production: In a condensation reaction UF resin is produced from urea and formalin at temperatures 50-100°C with very small amounts of formic acid and sodium hydroxide to control pH during reaction. Vacuum distillation to 65% dry content of the UF resin is included. 7. The MF resin is produced form formalin and melamine and a modifyer in a condensation reaction with sodium hydroxide to control pH. Vacuum distillation to 65% dry content of the MF resin was included. Inventory data for the modifyer were not available but was replaced by melamine data. 8. All ingredients are mixed at room temperature and the adhesive is made tixotropic by ultra-sound. It is pumped to a storage tank from where it is delivered on tank trucks, containers or steel drums. MUF 1241 is an adhesive which is used in the production of load-bearing timber structures, finger joints and blockboards where there is a demand for light coloured bond lines with high weather and water resistance. It can be used for cold pressing and high frequency pressing. There are different qualities of MUF adhesives which may have differences in open time, pressing time and after curing time. MUF resins ar not normally used for large, curved beams, where instead PRF adhesives are common. Overall information: All transports are included in the system. Abbreviations: MUF=Melamine-Urea-Formaldehyde resin UF= Urea-Formaldehyde resin MF= Melamine-Formaldehyde resin PRF=Phenol-Resorcinol-Formaldehyde resin

System Boundaries	
Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally, in dense populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1998, beeing yearly averages where possible. No great changes after that are estimated. The data from Casco Products plant in Kristinehamn are from 1999.
Geographical Boundary	The production of the raw materials natural gas, ammonia, methanol and urea is made on different sites in Europe. The production of formalin, melamin formaldehyde resin and urea-formaldehyde resin is made at Casco Products' plant, Kristinehamn, Sweden.
Other Boundaries	The packages for the product are not included in this study. Transports of materials to the production site in Kristinehamn as well as upstreams transports are included. The transportation to the users, use and final disposal of the glue is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included.

Allocations	Emissions and waste at the Kristinehamn factory where the formalin and resin is produced are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there. The steam generated in the formaldehyde process is used elsewhere in the factory. The energy produced is credited the formaldehyde.(See system expansion)
Systems Expansions	The production of formalin from methanol is an exothermic process.The heat produced is used for production of steam, which is utilised in other processes or for heating purposes. This steam replaces steam from oil that would otherwise have been needed. Therefore the steam produced in the process has been credited the formalin, i.e. oil consumption and emisssions were reduced. The amount of oil for production of steam on site and emissions from the boiler is known. (See Product Specific Requirements for Certified EPD for chemical products, www.environdec.com)

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Not relevant.
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in Casco Products' own factory data were taken from Environmental Report 1999 and Production Statistics 1999. Allocations were made on mass basis. For more information see About data.
Literature Reference	Casco Products, see About data
Notes	Prepared for Ecolab by Annika Olsson. Checked by Malin Bogeskär.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	43.59			g	Air	
	Input	Natural resource	Bauxite	0.35			g	Ground	
	Input	Natural resource	Cellulose	24			g	Ground	
	Input	Natural resource	Coal	1.75			MJ	Ground	
	Input	Natural resource	Copper ore	0.22			g	Ground	
	Input	Natural resource	Crude oil	3.87			MJ	Ground	
	Input	Natural resource	Feldspar	0.22			g	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	0.44			MJ	Ground	
	Input	Natural resource	Hydrogen	0.03			MJ	Air	
	Input	Natural resource	Iron in ore	0.06			g	Ground	
	Input	Natural resource	Lignite	0.14			MJ	Ground	
	Input	Natural resource	Limestone	0.41			g	Ground	
	Input	Natural resource	NaCl	6.71			g	Ground	
	Input	Natural resource	Natural gas	29.94			MJ	Ground	
	Input	Natural resource	Nitrogen	2.91			g	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	0.4			MJ	Ground	
	Input	Natural resource	Recovered energy	-0.31			MJ	Other	

	Input	Natural resource	S	3.73			g	Ground	
	Input	Natural resource	Uranium ore	0.13			g	Ground	
	Input	Natural resource	Wood	0.3			MJ	Ground	
	Output	Emission	BOD	31			mg	Water	
	Output	Emission	CO	0.66			g	Air	
	Output	Emission	CO2	1277			g	Air	
	Output	Emission	COD	1.209			g	Water	
	Output	Emission	Dimethylether	0.002			g	Air	
	Output	Emission	Dissolved solids	0.222			g	Water	
	Output	Emission	Dust	0.87			g	Air	
	Output	Emission	Formaldehyde	0.002			g	Air	
	Output	Emission	H+	31			mg	Water	
	Output	Emission	Hydrocarbons	1.8			g	Air	
	Output	Emission	Hydrocarbons	17			mg	Water	
	Output	Emission	Metals	57			mg	Water	
	Output	Emission	Methane	5.88			g	Air	
	Output	Emission	Methanol	0.1			g	Air	
	Output	Emission	N total	0.338			g	Water	
	Output	Emission	Na+	0.495			g	Water	
	Output	Emission	NH3	0.17			g	Air	
	Output	Emission	NOx	4.62			g	Air	
	Output	Emission	SO2	2.02			g	Air	
	Output	Emission	SOx	4.53			g	Air	
	Output	Emission	Suspended solids	0.483			g	Water	
	Output	Emission	Total organic carbon	0.225			g	Water	
Notes: MUF 1241 is a Melamine-Urea-Formaldehyde adhesive intended for load bearing timber structures and finger joints. It must be used with Hardener 2542.	Output	Product	MUF 1241	1			kg	Technosphere	
	Output	Residue	Building waste	0.07			g	Technosphere	
	Output	Residue	Hazardous waste	10.77			g	Technosphere	
	Output	Residue	Landfill	17.24			g	Technosphere	
	Output	Residue	Mineral waste	6.77			g	Technosphere	
	Output	Residue	Mixed industrial waste	0.9			g	Technosphere	
	Output	Residue	Non hazardous waste	10.66			g	Technosphere	
	Output	Residue	Slags and ash	1.68			g	Technosphere	
	Output	Residue	Sludge (dry matter)	2.06			g	Technosphere	
	Output	Residue	Waste to incineration	1.93			g	Technosphere	
	Output	Residue	Waste to recycling	3.42			g	Technosphere	

About Inventory	
Publication	------------------- Data documented by: Birgit Nilsson, Casco Products, Sweden. Documentation reviewed by: Karolina Flemström, IMI - Industrial environmental infomatics, Chalmers University of Technology, Sweden. Published in SPINE@CPM: 2003-05-28
Intended User	Users of Wood Adhesive Casco
General Purpose	
Detailed Purpose	To provide LCI data to producers of gluelam where MUF 1241 is used as an adhesive.
Commissioner	- Europe.
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	

Applicability	MUF 1241 is a wood adhesive for laminated beams, which gives a light coloured joint. It is always used with hardener 2542. All adhesives for bonding of gluelam must have an approval from an independent institute to be allowed to use in the production of load-bearing timber structures and finger joints. MUF 1241 is approved for the production of load-bearing structures by NTI, Norway, Otto-Graf Institute (FMPA), Germany and SKH/KOMO, Holland. For more product data call Casco Products, +46 8 743 4000.
About Data	For the production of formaldehyde, UF and MF and all data originates from Casco Products' factory in Kristinehamn. For raw materials suppliers have participated on terms that their data will be treated confidentially. For urea and formic acid gate- to- gate data were provided, for methanol and sodium hydroxide cradle -to gate. For ammonia and fuel data from APME Ecoprofiles are used. Raw materials used are mentioned under ''Object of study/Functions) Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1997 from ''Annual Energy Review 1999'' (European comission) Building of the power plant is not included. Abbreviations: MUF= Melamine-Urea-Formaldehyde adhesive APME= Association of Plastics Manufacures NTI= Norsk Treteknisk Institut
Notes	

SPINE LCI dataset: Production of Melamin-Urea-Formaldehyde resin 1242(MUF 1242), Wood Adhesive

Administrative	
Finished	Y
Date Completed	2003-03-26
Copyright	Casco Products
Availability	

Technical System	
Name	Production of Melamin-Urea-Formaldehyde resin 1242(MUF 1242), Wood Adhesive
Functional Unit	1 kg MUF 1242
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg MUF 1242. The wood adhesive is delivered with 65% dry content. The content of free formaldehyde is 0.6% Abbreviation: MUF= Melamine-Formaldehyde adhesive
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	MUF 1242 is produced by Casco Products in Kristinehamn. It is a mixture of an UF and a MF resin, celllulose filler, solvent and acrylate copolymer dispersion. Small amounts of sodium hydroxide and formic acid are used for pH adjustments. Additves are silcic acid for thixotrophy and defoamer. All ingredients except the celluolse filler, silicic acid and defoamer could be followed to the cradle. Packages are not included. The production of the UF and MF resins and formaldehyde takes place at the same site in Kristinehamn. Sodium hydroxide is manufactured in Sweden and transported a short distance by truck, while the main raw materials urea, melamine and methanol are produced in different parts of Europe. Urea and methanol are transported by sea as bulk transports and melamine by truck, most of it in Big Bags.

	The processes use steam which is produced on site from oil and electricty form the net. The main steps of MUF 1242 production are: 1. Natural gas production: The study includes winning, delivery to shore and storage. Natural gas is used in the production of methanol and ammonia. 2. Methanol production: Natural gas is produced into synthesis gas in reformers. Synthesis gas is converted to raw methanol in a catalytic process and distilled into finished methanol. Storage is included. 3. Formalin production: Formalin is produced from methanol by oxidation in the Formox process. The process is exothermic and produces steam, which is utilised in the plant. 4. Ammonia and urea production: Ammonia is produced from natural gas, air and water in a steam reforming process. In the process carbon dioxide is produced. The urea plant is situated on the same site as the ammonia plant. Urea is produced by reacting ammonia and carbon dioxide at 150 bar at an operation temparature of 185-190°C. The carbon dioxide used in the urea process comes from the ammonia process. Excess carbon dioxide is accounted for as emission to air. 4. Formic acid is produced from sodium formate and sulphuric acid with sodium sulphate as a by-product. 5. Sodium hydroxide is produced from soduim chloride in an electrolytic reaction. 6. UF resin production: In a condensation reaction UF resin is produced from urea and formalin at temperatures 50-100°C with very small amounts of formic acid and sodium hydroxide to control pH during reaction. Vacuum distillation to 65% dry content of the UF resin is included. 7. The MF resin is produced form formalin and melamine in the presence of methanol to ethrify the resin in a condensation reaction with sodium hydroxide to control pH. Vacuum distillation to 65% dry content of the MF resin was included. . 8. All ingredients are mixed at room temperature and the adhesive is made tixotropic by ultra-sound. It is pumped to a storage tank from where it is delivered on tank trucks, containers or steel drums. MUF 1242 is an adhesive which is used in the production of load-bearing timber structures, finger joints and blockboards where there is a demand for light coloured bond lines with high weather and water resistance. It can be used for cold pressing and high frequency pressing. There are different qualities of MUF adhesives which may have differences in open time, pressing time and after curing time. MUF resins ar not normally used for large, curved beams, where instead PRF adhesives are common. Overall information: All transports are included in the system. Abbreviations: MUF= Melamine-Urea-Formaldehyde resin UF= Urea-formaldehyde resin MF= Melamine-Formaldehyde reins PRF=Phenol-Resorcinol-Formaldehyde resin

System Boundaries

Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally, in dense populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1998, beeing yearly averages where possible. No great changes after that are estimated. The data from Casco Products plant in Kristinehamn are from 1999.
Geographical Boundary	The production of the raw materials natural gas, ammonia, methanol and urea is made on different sites in Europe. The production of formalin, melamin formaldehyde resin and urea-formaldehyde resin is made at Casco Products' plant, Kristinehamn, Sweden.
Other Boundaries	The packages for the product are not included in this study. Transports of materials to the production site in Kristinehamn as well as upstreams transports are included. The transportation to the users, use and final disposal of the glue is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included.

Allocations	Emissions and waste at the Kristinehamn factory where the formalin and resin is produced are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there. The steam generated in the formaldehyde process is used elsewhere in the factory. The energy produced is credited the formaldehyde.(See system expansion)
Systems Expansions	The production of formalin from methanol is an exothermic process.The heat produced is used for production of steam, which is utilised in other processes or for heating purposes. This steam replaces steam from oil that would otherwise have been needed. Therefore the steam produced in the process has been credited the formalin, i.e. oil consumption and emisssions were reduced. The amount of oil for production of steam on site and emissions from the boiler is known. (See Product Specific Requirements for Certified EPD for chemical products, www.environdec.com)

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Not relevant.
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from Environmental Report 1999 and Production Statistics 1999. Allocations were made on mass basis.
Literature Reference	Casco Products, see About data
Notes	Prepared for Ecolab by Annika Olsson. Checked by Malin Bogeskär.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Air	52.87			g	Air	
	Input	Natural resource	Bauxite	0.53			g	Ground	
	Input	Natural resource	Cellulose	24			g	Ground	
	Input	Natural resource	Coal	1.86			MJ	Ground	
	Input	Natural resource	Copper ore	0.25			g	Ground	
	Input	Natural resource	Crude oil	4.68			MJ	Ground	
	Input	Natural resource	Feldspar	0.24			g	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	0.49			MJ	Other	
	Input	Natural resource	Hydrogen	0.03			MJ	Air	
	Input	Natural resource	Iron in ore	0.06			g	Ground	
	Input	Natural resource	Lignite	0.15			MJ	Ground	
	Input	Natural resource	Limestone	0.45			g	Ground	
	Input	Natural resource	NaCl	1.73			g	Ground	
	Input	Natural resource	Natural gas	42.51			MJ	Ground	
	Input	Natural resource	Nitrogen	3.18			g	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	0.48			MJ	Ground	
	Input	Natural resource	Recovered energy	-0.33			MJ	Other	

	Input	Natural resource	Rock salt	2.95			g	Ground	
	Input	Natural resource	S	1.15			g	Ground	
	Input	Natural resource	Uranium ore	0.14			g	Ground	
	Output	Emission	BOD	31			mg	Water	
	Output	Emission	CO	0.76			g	Air	
	Output	Emission	CO2	1595			g	Air	
	Output	Emission	COD	1.269			g	Water	
	Output	Emission	Dimethylether	0.002			g	Air	
	Output	Emission	Dissolved solids	159			mg	Water	
	Output	Emission	Dust	0.98			g	Air	
	Output	Emission	Formaldehyde	0.002			g	Air	
	Output	Emission	Formaldehyde	0.002			g	Air	
	Output	Emission	H+	49			mg	Water	
	Output	Emission	Hydrocarbons	17			mg	Water	
	Output	Emission	Hydrocarbons	2.45			g	Air	
	Output	Emission	Metals	57			mg	Water	
	Output	Emission	Methane	7.88			g	Air	
	Output	Emission	Methanol	0.1			g	Air	
	Output	Emission	N total	0.341			g	Water	
	Output	Emission	Na+	0.523			g	Water	
	Output	Emission	NH3	0.16			g	Air	
	Output	Emission	NH4+	68			mg	Water	
	Output	Emission	NOx	5.91			g	Air	
	Output	Emission	Oil and fat	44			mg	Water	
	Output	Emission	Propylene	0.49			g	Air	
	Output	Emission	SO2	2.96			g	Air	
	Output	Emission	SO42-	0.928			g	Water	
	Output	Emission	SOx	4.77			g	Air	
	Output	Emission	Suspended solids	0.495			g	Water	
	Output	Emission	Total organic carbon	0.23			g	Water	
Notes: MUF 1242 is a Melamine-Urea-Formaldehyde adhesive intended for the production of load-bearing timber structures and finger joints. It must be used with hardener 2542.	Output	Product	MUF 1242	1			kg	Technosphere	
	Output	Residue	Building waste	0.07			g	Technosphere	
	Output	Residue	Hazardous waste	11.02			g	Technosphere	
	Output	Residue	Landfill	17.29			g	Technosphere	
	Output	Residue	Mineral waste	8.04			g	Technosphere	
	Output	Residue	Mixed industrial waste	0.96			g	Technosphere	
	Output	Residue	Non hazardous waste	11.86			g	Technosphere	
	Output	Residue	Slags and ash	1.92			g	Technosphere	
	Output	Residue	Sludge (dry matter)	2.07			g	Technosphere	
	Output	Residue	Waste to incineration	1.95			g	Technosphere	
	Output	Residue	Waste to recycling	3.63			g	Technosphere	

About Inventory

Publication	----------------- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Karolina Flemström, IMI - Industrial environmental informatics, Chalmers University of Technology, Sweden Published in SPINE@CPM: 2003-05-28
Intended User	Users of Wood Adhesive Casco
General Purpose	

Detailed Purpose	To provide LCI data to producers of gluelam where MUF 1242 is used as an adhesive.
Commissioner	- Europe.
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	MUF 1242 is a wood adhesive for laminated beams, which gives a light coloured joint. It is used with hardener 2542. All adhesives for bonding of gluelam must have an approval from an independent institute to be allowed to use in the production of load-bearing timber structures and finger joints. MUF 1242 is approved for the production of load-bearing structures by NTI, Norway, Otto-Graf Institute (FMPA), Germany, CTBA, France, BUtgb, Belgium and SKH/KOMO, Holland. The different abbreviations above refers to the Institutes that have made the approval tests. For more product data call Casco Products, +46 8 743 4000.
About Data	For the production of formaldehyde, UF and MF and all data originates from Casco Products' factory in Kristinehamn. For raw materials suppliers have participated on terms that their data will be treated confidentially. For urea and formic acid gate- to- gate data were provided, for methanol and sodium hydroxide cradle -to gate. For ammonia and fuel data from APME Ecoprofiles are used. Raw materials used are mentioned under ''Object of study/Functions) Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1997 from ''Annual Energy Review 1999'' (European comission) Building of the power plant is not included. Abbreviations: MUF= Melamine-Urea-Formaldehyde adhesive APME_ Association of Plastics Manufacures NTI= Norsk Treteknisk Institut
Notes	

SPINE LCI dataset: Production of methanol using energy forest

Administrative	
Finished	Y
Date Completed	1996
Copyright	
Availability	

Technical System	
Name	Production of methanol using energy forest
Functional Unit	1 MJ
Functional Unit Explanation	The amounts in the table show the environmental load per MJ produced methanol.
Process Type	Gate to gate
Site	
Sector	Fuel
Owner	
Technical system description	Production of methanol using energy forest The wood from the energy forest (Willow) is dried and preheated before it is taken to the gasification. The gasification consists of two different steps, which are partial oxidation and

	pyrolysis. During the partial oxidation oxygen is added to the biomass and carbon monoxide is produced. This is an ectoderm reaction and therefore is emits heat. This heat is needed for the pyrolysis, during which carbondioxide and hydrogen are produced. The oxygen is separated from the air through distillation. The gas must also be cleansed from other kind of pollutants, because otherwise the methanol catalyst gets inactivated. The cleansed gas is compressed to synthesis-pressure (approximately 60 bar) and is then taken to the methanol-reactor.

System Boundaries

Nature Boundary	The energy consumption and the emissions to air are accounted for. Also the raw material used is reported in the data.
Time Boundary	The most advanced technology is acounted for in the study.
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	
Represents	Not relevant.
Method	Literatue study of Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5, where the data are taken from Johansson B, 1996, Transportation fuels from Swedish biomass - Environmental ans cost aspects, Transportation reasearch pp 47 -62, Elciver Science Ltd, Exter UK. No information is given in the report (Blinge, 1996) conserning the selection of data.
Literature Reference	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Notes	Prepared for Ecolab by Annika Olsson. Checked by Malin Bogeskär.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Willow	2			MJ	Forestral ground	
	Input	Refined resource	Electricity	0.0985			MJ	Technosphere	
	Output	Emission	CO	18.414			mg	Air	
	Output	Emission	CO2	125678.77			mg	Air	
	Output	Emission	HC	8.64			mg	Air	
	Output	Emission	NOx	10.153			mg	Air	
	Output	Emission	SOx	3.96			mg	Air	
	Output	Emission	Susp solids	0.15			mg	Air	
	Output	Product	Methanol	1			MJ	Technosphere	

About Inventory

Publication	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5. -- Data documented by: Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Persons or companies intereste
General Purpose	
Detailed Purpose	The data are part of a study concerning alternative fuels
Commissioner	- KFB Komunikations Forsknings Beredningen Box 5706 Linnégatan 2 114 87 Stockholm Sweden.

Practitioner	Blinge Magnus, Arnäs P, Bäckström S, Furnander Å, Hovelius K - Department of Transportation and Logistics Chalmers University of Thechnology.
Reviewer	
Applicability	The data is taken from experimental production, and can therefore not be used with success to evaluate the present situation. Testing plants that need not function economically is not to be equalled to commercially producing plants. Because the environmental load is not proportional to the production amount this data should not be used on plants with much greater or smaller production. The data conserning the energy forest (Willow) used in the production can be found in SPINE in the activity Production of energy forest.
About Data	
Notes	

SPINE LCI dataset: Production of methylene diphenyl diisocyanate, MDI (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of methylene diphenyl diisocyanate, MDI (APME)
Functional Unit	1 kg MDI - Methylene diphenyl diisocyanate
Functional Unit Explanation	MDI, methylene diphenyl diisocyanate, is one of the precursors used in the production of polyurethanes. There are five main areas of use for polyurethanes: the furniture and mattress sector, the automotive industry, the consumer sector, the building industry and the
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. All flows have been followed to the cradle. However, only the main production process is been described here. MDI, methylene diphenyl diisocyanate, is one of the precursors used in the production of polyurethanes. MAIN PROCESS: 1. Extraction of crude oil 2. Oil refining 3. Benzene production 4. Nitrobenzene production 5. Aniline production 6. MDA (methylene dianiline) production 7. MDI production SUB PROCESSES: a. Production of sulphur and sulphuric acid, to be used in the production of nitrobenzene b. Production of hydrogen for the aniline production. c. Production of methanolo from natural gas - production of formaldehyde from the methanol. The formaldehyde is used for the MDA production. d. Production of ammonia from natural gas. The ammonia is used fro the benzene production. The ammonia is also used to produce nitric acid, which is used in the production of nitrobenzene. e. Production of phosgene from carbon monoxide and chlorine. The carbon monoxide is produced from coke/natural gas. The chlorine is produced from sodium chloride. The

	phosgene is used from the MDI production step. The inputs to the process are crude oil, natural gas, sulphur, coke/naturalgas, sodium chloride and the by-product sulphur dioxide. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1995-1996. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 5 producers in Belgium, Germany, Italy and the Netherlands. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 5 MDIproduction plants in 4 countries: Belgium, Italy, Germany and the Netherlands. Their total production was 557,000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid

	cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1995-1996
Data Type	Derived, mixed
Represents	Not relevant.
Method	European average data. Results are based on data supplied by 5 MDI production plants in 4 countries: Belgium, Italy, Germany and the Netherlands. Their total production was 557,000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME - Association of Plastics Manufacturers in Europe, website: http://lca.apme.org
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Air	420848.4321			mg	Air	Europe
	Input	Natural resource	Barytes	182.313477			mg	Ground	Europe
	Input	Natural resource	Bauxite	215.1070064			mg	Ground	Europe
	Input	Natural resource	Bentonite	98.8626278			mg	Ground	Europe
	Input	Natural resource	Biomass	4308.016196			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	9.84150952			mg	Ground	Europe
	Input	Natural resource	Chalk	1.16E-23			mg	Ground	Europe
	Input	Natural resource	Chromium in ore	7.01E-07			mg	Ground	Europe
	Input	Natural resource	Clay	10.96847121			mg	Ground	Europe

		Input	Natural resource	Crude oil	498519.2564			mg	Ground	Europe
		Input	Natural resource	Dolomite	43.29015072			mg	Ground	Europe
		Input	Natural resource	Feldspar	1.47E-29			mg	Ground	Europe
		Input	Natural resource	Ferromanganese	0.594445828			mg	Ground	Europe
		Input	Natural resource	Fluorite	3.222470165			mg	Ground	Europe
		Input	Natural resource	Granite	2.39E-02			mg	Ground	Europe
		Input	Natural resource	Gravel	2.224645389			mg	Ground	Europe
		Input	Natural resource	Hard coal	321096.3224			mg	Ground	Europe
		Input	Natural resource	Hydro energy	0.504996345			MJ	Ground	Europe
		Input	Natural resource	Iron in ore	697.2895183			mg	Ground	Europe
		Input	Natural resource	Lead in ore	1.824228531			mg	Ground	Europe
		Input	Natural resource	Lignite	101969.6316			mg	Ground	Europe
		Input	Natural resource	Limestone	20036.78997			mg	Ground	Europe
		Input	Natural resource	Metallurgical coal	17769.63378			mg	Ground	Europe
		Input	Natural resource	Natural gas	1097357.656			mg	Ground	Europe
		Input	Natural resource	Nickel in ore	0.109593303			mg	Ground	Europe
		Input	Natural resource	Nitrogen	127041.4279			mg	Ground	Europe
		Input	Natural resource	Nuclear energy	5.51299683			MJ	Ground	Europe
		Input	Natural resource	Olivine	5.963022144			mg	Ground	Europe
		Input	Natural resource	Oxygen	150086.3185			mg	Ground	Europe
		Input	Natural resource	Peat	369.2391523			mg	Ground	Europe
		Input	Natural resource	Phosphate	7.208932294			mg	Ground	Europe
		Input	Natural resource	Potassium chloride	12882.51663			mg	Ground	Europe
		Input	Natural resource	Rutile	1.67E-23			mg	Ground	Europe
		Input	Natural resource	Sand	821.4974124			mg	Ground	Europe
		Input	Natural resource	Shale oils	27.86131345			mg	Ground	Europe
		Input	Natural resource	Sodium chloride	471493.8802			mg	Ground	Europe
		Input	Natural resource	Sulphur	4905.315648			mg	Ground	Europe
		Input	Natural resource	Sulphur (bonded)	2441.899215			mg	Ground	Europe
		Input	Natural resource	Water, cooling	276402200.6			mg	Water	Europe
		Input	Natural resource	Water, process	84124967			mg	Water	Europe
		Input	Natural resource	Wood	806.4279906			mg	Ground	Europe
		Input	Natural resource	Zinc in ore	5.71E-02			mg	Ground	Europe
		Output	Co-product	Recovered energy	4.627478011			MJ	Technosphere	Europe
		Output	Emission	1,2-Dichloroethane	2.60E-05			mg	Air	Europe
		Output	Emission	Acid as H+	42.0974748			mg	Water	Europe
		Output	Emission	Al	8.415284821			mg	Water	Europe
		Output	Emission	Aldehydes	1.562200034			mg	Air	Europe
		Output	Emission	As	2.80E-04			mg	Water	Europe
		Output	Emission	BOD5	814.8387071			mg	Water	Europe

	Output	Emission	Ca2+	112.5958223			mg	Water	Europe
	Output	Emission	CFCs	2.894967239			mg	Air	Europe
	Output	Emission	Chloroorganics	12.15327877			mg	Air	Europe
	Output	Emission	Chloroorganics	3.297053857			mg	Water	Europe
	Output	Emission	Cl-	142499.5935			mg	Water	Europe
	Output	Emission	Cl2	0.602185536			mg	Air	Europe
	Output	Emission	Cl2	11.16844301			mg	Water	Europe
	Output	Emission	CN-	1.35E-02			mg	Water	Europe
	Output	Emission	CO	2796.799443			mg	Air	Europe
	Output	Emission	CO2	3382476.452			mg	Air	Europe
	Output	Emission	CO32-	147.4355949			mg	Water	Europe
	Output	Emission	COD	5347.148016			mg	Water	Europe
	Output	Emission	CrO3	8.43E-07			mg	Water	Europe
	Output	Emission	CS2	2.49E-04			mg	Air	Europe
	Output	Emission	Cu	0.161499042			mg	Water	Europe
	Output	Emission	Dissolved organics	329.9612663			mg	Water	Europe
	Output	Emission	Dissolved solids	8186.706777			mg	Water	Europe
	Output	Emission	F-	3.75E-03			mg	Water	Europe
	Output	Emission	F2	2.75E-03			mg	Air	Europe
	Output	Emission	Fe	1.879585663			mg	Water	Europe
	Output	Emission	H2	1800.721572			mg	Air	Europe
	Output	Emission	H2S	0.517099001			mg	Air	Europe
	Output	Emission	H2SO4	15.91785856			mg	Air	Europe
	Output	Emission	HCl	134.9068456			mg	Air	Europe
	Output	Emission	HCN	5.71E-29			mg	Air	Europe
	Output	Emission	HF	6.030281778			mg	Air	Europe
	Output	Emission	Hg	0.321388128			mg	Water	Europe
	Output	Emission	Hg	0.406742106			mg	Air	Europe
	Output	Emission	K+	369.3147008			mg	Water	Europe
	Output	Emission	Metals	234.1358744			mg	Water	Europe
	Output	Emission	Metals	6.838957934			mg	Air	Europe
	Output	Emission	Methane	17825.51088			mg	Air	Europe
	Output	Emission	Mg	14.6599637			mg	Water	Europe
	Output	Emission	N total	63.39169854			mg	Water	Europe
	Output	Emission	N2O	0.127884205			mg	Air	Europe
	Output	Emission	Na	95871.52424			mg	Water	Europe
	Output	Emission	NH3	40.64987605			mg	Air	Europe
	Output	Emission	NH4+	204.5531643			mg	Water	Europe
	Output	Emission	Ni	7.628218187			mg	Water	Europe
	Output	Emission	NO3-	153.6808522			mg	Water	Europe
	Output	Emission	NOx	15085.24156			mg	Air	Europe
	Output	Emission	Oil	38.82394019			mg	Water	Europe
	Output	Emission	Other organics	158.5275045			mg	Water	Europe
	Output	Emission	Particles	4734.127239			mg	Air	Europe
	Output	Emission	Pb	1.99E-04			mg	Air	Europe
	Output	Emission	Pb	4.69E-04			mg	Water	Europe
	Output	Emission	Phenol	4.824860716			mg	Water	Europe
	Output	Emission	PO43-	9.440771951			mg	Water	Europe
	Output	Emission	S2-	0.697170589			mg	Water	Europe
	Output	Emission	SO2	14587.96741			mg	Air	Europe
	Output	Emission	SO42-	6073.240307			mg	Water	Europe
	Output	Emission	Suspended solids	2331.729683			mg	Water	Europe
	Output	Emission	Thiols	7.26E-02			mg	Air	Europe
	Output	Emission	Vinyl chloride	2.18E-26			mg	Water	Europe
	Output	Emission	Vinyl chloride	2.59E-05			mg	Air	Europe
	Output	Emission	VOC	39.02861248			mg	Water	Europe
	Output	Emission	VOC	3989.291933			mg	Air	Europe
	Output	Emission	VOC	63.49293054			mg	Air	Europe
	Output	Emission	VOC, aromatic	72.55037345			mg	Air	Europe
	Output	Emission	Zn	51.32797735			mg	Water	Europe
	Output	Product	MDI (methylene diphenyl diisocyanate)	1			kg	Technosphere	Europe
	Output	Residue	Construction	78.34316035			mg	Ground	Europe
	Output	Residue	Industrial	10519.78445			mg	Ground	Europe
	Output	Residue	Inert chemical	2840.631442			mg	Ground	Europe

	Output	Residue	Metals	14.77700161			mg	Ground	Europe
	Output	Residue	Mineral	83807.13934			mg	Ground	Europe
	Output	Residue	Paper	4.871958434			mg	Ground	Europe
	Output	Residue	Plastics	162.4004846			mg	Ground	Europe
	Output	Residue	Regulated chemical	4662.541479			mg	Ground	Europe
	Output	Residue	Slags & ashes	20716.44427			mg	Ground	Europe
	Output	Residue	To incinerator	1662.112905			mg	Technosphere	Europe
	Output	Residue	To recycling	366.8777036			mg	Technosphere	Europe
	Output	Residue	Unspecified	11.89029197			mg	Ground	Europe
	Output	Residue	Wood waste	7.939058986			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for MDI. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. -- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 3 April 2002 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	
Practitioner	Boustead, Ian - .
Reviewer	Not available -
Applicability	The data are applicable to both MDI monomer and polymer; differences between the two have been found to be insignificant. European average data. Results are based on data supplied by 5 MDI production plants in 4 countries: Belgium, Italy, Germany and the Netherlands. Their total production was 557,000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.

About Data	European average data for MDI production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of MDI in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics

	Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

SPINE LCI dataset: Production of mounting fluid

Administrative	
Finished	Y
Date Completed	2002-12-12
Copyright	
Availability	Public

Technical System	
Name	Production of mounting fluid
Functional Unit	1 kg mounting fluid
Functional Unit Explanation	The density of SKF LHMF 300 is 0.894 kg/l.
Process Type	Gate to gate
Site	Huizingen, Belgium
Sector	Materials and components
Owner	Huizingen, Belgium
Technical system description	A mounting fluid is used for facilitate the mounting or dismounting of a bearing. The mounting fluid SKF LHMF 300 is fabricated from paraffinic mineral oil, alkyl metacrylate, and the anti rust additive long chain alkylcarboxilic acid.

System Boundaries	
Nature Boundary	No emissions are included since ther amount are regarded very small.
Time Boundary	Data is collected autumn 2002. No changes in the procedure are planned for the nearest future.
Geographical Boundary	The fabrication takes place at Huizingen, Belgium.
Other Boundaries	Electricity consumption is excluded due to lack of data. Transports are not included either.
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	2002-09-01 - 2002-12-31
Data Type	Unspecified, expert outspoke
Represents	N/A
Method	Personal communication with Harry Warmer and Magnus Rydin, SKF Maintenance Products.
Literature Reference	N/A

Notes	The alkyl metacrylate has been estimated with polymethyl metacrylate since no other information could be achieved.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refine resource	alkyl metacrylate	0.1			kg	Technosphere	Europe
	Input	Refine resource	alkylcarboxilic acid	0.05			kg	Technosphere	Europe
	Input	Refine resource	Crude oil	0.85			kg	Technosphere	Europe
	Output	Product	SKF LHMF 300	1			kg	Technosphere	Europe

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002. -------------- Data documented by Sandra Häggström, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-03-21.
Intended User	Product developer at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The purpose for our study is to compare a coated roller bearing to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll using SKF LHMF 300 in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	Applicable for mounting fluids.
About Data	Personal communication with Harry Warmer and Magnus Rydin, SKF Maintenance Products.
Notes	

SPINE LCI dataset: Production of nitric acid

Administrative

Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public (confidential energy flow data are not included)

Technical System

Name	Production of nitric acid
Functional Unit	1 kg of nitric acid (100 %)
Functional Unit Explanation	
Process Type	Gate to gate
Site	Hydro Agri AB Box 908 SE-731 29 Köping Sweden
Sector	Materials and components
Owner	Hydro Agri AB Box 908 SE-731 29 Köping Sweden

Technical system description	The nitric acid production step is one step in the line of production of NPK fertilisers at the site in Köping. The nitric acid is neutralised with ammonia to produce ammonum nitrate that in turn is mixed with other components forming NPK fertilisers. At Hydro Agri AB in Köping there are two nitric acid plants. The old plant, built in 1956, has higher emissions and produces less energy than the new plant built in 1982. The old plant is operated at atmospheric pressure and the new plant built is operated at intermediate pressure. The dataset represents an average of the two plants. References: Miljörapport Hydro Agri AB Köping (1998). Official environmental report. Hydro Agri AB, Box 908, 731 29 Köping. Personal communication: Karlsson L-H (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27800

System Boundaries

Nature Boundary	The system starts with input of ammonia and energy and ends with nitric acid leaving the factory gate, i.e production of ammonia and energy are not not included in this dataset.
Time Boundary	The data are taken from production in 1997.
Geographical Boundary	The nitric acid plants are situated in Köping, Sweden.
Other Boundaries	
Allocations	Emissions of nitrogen to water and consumption/production of energy due to the nitric acid production are included in the emissions and energy consumption/production related to the production of ammonium nitrate.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	N/A
Method	Amount of ammonia consumed in the production of nitric acid was calculated by using the molecular mass of nitric acid and ammonia respectively. Average values for emissions of nitric oxides from the two nitric acid plants at the site were given in kg/d and these values were therefor multiplied by 365, summarised and then divided by the total amount of nitric acid produced at the plants in 1997. The total amount of emissions nitrous oxides was divided by the total amount of nitric acid produced at the two plants in 1997. Emissions of nitrogen to water and consumption/production of energy due to the nitric acid production are included in the emissions and energy consumption/production related to the production of ammonium nitrate.
Literature Reference	Miljörapport Hydro Agri AB Köping, (1998). Official environmental report. Hydro Agri AB, Box 908, 731 29 Köping. Personal communication: Andersson B (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27834. Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Karlsson L-H (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27800
Notes	Emissions of nitrogen to water and consumption/production of energy due to the nitric acid production are included in the emissions and energy consumption/production related to the production of ammonium nitrate. The energy consumption/production is confidential.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: Amount of ammonia consumed in the production of nitric acid was calculated by using the molar mass of nitric acid and ammonia respectively. (17 g/mole) / (63 g/mol) = 0,27 kg NH3/kg HNO3 Literature: Personal communication: Mats Karlsson (1998), Hydro Agri AB Landskrona, Sweden. tel: +46 418 76100 Notes: Bought from spot market in the Baltic sea, origin is Poland or Russia.	Input	Refined resource	Ammonia	0.270			kg	Technosphere	Sweden

Notes: Consumption/production of energy due to the nitric acid production were included in the energy consumption/production related to the production of ammonium nitrate.	Input	Refined resource	District heat				MJ	Technosphere	Sweden
Notes: Consumption/production of energy due to the nitric acid production were included in the energy consumption/production related to the production of ammonium nitrate.	Input	Refined resource	Electricity				MJ	Technosphere	Sweden
Notes: Consumption/production of energy due to the nitric acid production were included in the energy consumption/production related to the production of ammonium nitrate.	Input	Refined resource	Steam				MJ	Technosphere	Sweden
Data type: Derived, mixed Method: The total amount of emissions nitrous oxides was divided by the total amount of nitric acid produced at the two plants in 1997.	Output	Emission	N2O	9.02			g	Air	Sweden
Method: Average values for emissions of nitric oxides from the two nitric acid plants at the site were given in kg/d and these values were therefor multiplied by 365, summarised and then divided by the total amount of nitric acid produced at the plants in 1997.	Output	Emission	NO2	1.01			g	Air	Sweden
Notes: Emissions of nitrogen to water due to the nitric acid production were included in the emissions related to the production of ammonium nitrate.	Output	Emission	N-tot				g	Water	Sweden
Notes: Nitric acid (100 % HNO3)	Output	Product	Nitric acid	1			kg	Technosphere	Sweden

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources for the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other, but to generate a thorough inventory of emissions and use of resources due to the production of different mineral fertilisers. Production of nitric acid is one process step in the production of fertilisers containing nitrogen. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The dataset is applicable for production of nitric acid used in fertiliser production at Hydro Agri AB in Köping, Sweden. The dataset is included in aggregated datasets for fertiliser production at Hydro Agri AB in Köping (cradle to gate).
About Data	Data are collected from the official environmental report distributed by Hydro Agri AB in Köping and also by comminication with Lars-Håkan Karlsson and Bo Andersson, Hydro Agri AB in Köping.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of nitric acid (Landskrona)

Administrative	
Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public

Technical System	
Name	Production of nitric acid (Landskrona)
Functional Unit	1 kg of nitric acid (100 %)
Functional Unit Explanation	
Process Type	Gate to gate
Site	Hydro Agri AB Box 516 SE-261 24 Landskrona Sweden
Sector	Materials and components
Owner	Hydro Agri AB Box 516 SE-261 24 Landskrona Sweden
Technical system description	Production of nitric acid: Gaseous ammonia is mixed with pressurised air and the blend is combusted on a net of platina catalyst forming nitrogen monoxide. The process is operated at intermediate pressure. This reaction yields heat which is used to produce steam which in turn is partly used for internal heating within the system and partly transported to a district-heating network. The nitric monoxide gas is cooled and air is added, oxidising the nitrogen monoxide into nitrogen dioxide. The nitric acid is then dissolved in water in two absorption towers under intermediate pressure, forming nitric acid as final product. The tailgas from the two absorption towers is heated to 230 °C with incoming process gas. After addition of ammonia the tailgas is led to a NOX reactor where 90 % of the nitric oxides reacts on a catalyst into water and nitrogen gas. The residual gas passes a turbine that compresses the incoming air and a feed water heater before leaving the plant from a stack, 40 m in height. Reference: Miljörapport Hydro Agri AB Landskrona (1998). Official environmental report. Hydro Agri AB, Box 516, 261 24 Landskrona

System Boundaries	
Nature Boundary	The nature boundary is at the incoming and outgoing factory gate, i.e production of electricity, steam, district heat and supply materials are not included.
Time Boundary	The data are figures for production in 1997.
Geographical Boundary	Hydro Agri AB in Landskrona, Sweden.
Other Boundaries	Emissions from production of electricity and ''negative'' emissions from production of steam and district heating are not included in this dataset.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data	
General Activity QMetaData	
Date Conceived	1997-01-01
Data Type	Derived, unspecified

Represents	N/A
Method	Amount of ammonia consumed in the production of nitric acid was calculated by using the molecular mass of nitric acid and ammonia respectively. Example: M(NH3): 17g/mole M(HNO3): 63 g/mole Þ (17 g/mole) / (63 g/mole) = 0.27 t NH3/t HNO3 Total amounts of emissions of nitric oxides (NOx), nitrous oxides (N2O) and nitrogen (NO-3-N, NH4+-N) to water from the nitric acid plant have been divided by total amounts nitric acid produced in 1997. Emissions of nitric oxides (NOx) have been calculated as nitrogen dioxide. Example: M(N): 14 g/mole M(NO2): 46 g/mole Þ (35 t NOx-N/yr) / (94 000 t HNO3/yr) * (46 g/mole) / (14 g/mole) = 1.22 kg NOx/t HNO3 Total amounts of district heat and steam produced at the nitric acid plant have been divided by total amounts of nitric acid produced during 1997. Example: (62 500 MWh steam/yr) / (94 000 t HNO3/yr) * (3.6 GJ/MWh) = 2.39 GJ/t HNO3 The total net consumption of electricity (electricity is also produced at the plant) was divided by total amount of nitric acid produced in 1997. See also ''Specific QMetaData''.
Literature Reference	Miljörapport (official environmental report) 1997, Hydro Agri AB, Box 516, 261 24 Landskrona, Sweden. Personal communication: Göte Bertilsson (1998), Hydro Agri AB Landskrona, tel. +46 418 76100 Ronnie Persson (1998), Hydro Agri AB Landskrona, tel +46 418 76100
Notes	Emissions of nitrogen to water and consumption/production of energy due to the nitric acid production are included in the emissions and energy consumption/production related to the production of ammonium nitrate. The energy consumption/production is confidential.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Method: Amount of ammonia consumed in the production of nitric acid was calculated by using the molar mass of nitric acid and ammonia respectively. (17 g/mole) / (63 g/mol) = 0,27 kg NH3/kg HNO3 Literature: Personal communication: Mats Karlsson (1998), Hydro Agri AB Landskrona, Sweden. tel: +46 418 76100 Notes: Bought from spot market in the Baltic sea, origin is Poland or Russia.	Input	Refined resource	Ammonia	0.270			kg	Technosphere	Sweden
Notes: District heat is delivered from the process and transported to the local district heating network.	Input	Refined resource	District heat	-2.39			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity	0.958			MJ	Technosphere	Sweden
Notes: Excess steam is produced from the process.	Input	Refined resource	Steam	-0.624			MJ	Technosphere	Sweden
Data type: Derived, mixed Method: The total amount of nitrous oxid released from the nitric acid plant has been divided by the total amount of nitric acid produced in 1997.	Output	Emission	N2O	7.27			g	Air	Sweden
Method: Total amount of emissions of nitric oxides (NOx) from the nitric acid plant has been divided by total amounts nitric acid produced in 1997. Emissions of nitric oxides (NOx) have been calculated as nitrogen dioxide.	Output	Emission	NO2	1.22			g	Air	Sweden
Method: Nitrogen (NO-3-N, NH4+-N) to water from the nitric acid plant have been divided by total amounts nitric acid produced in 1997.	Output	Emission	N-tot	0.132			g	Water	Sweden
	Output	Product	Nitric acid	1			kg	Technosphere	Sweden

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. --- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	The data are intended to be us
General Purpose	To generate an inventory over emissions and use of resources due to the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other but to generate a thorough inventory of emissions and use of resources due to the production of different mineral fertilisers. Production of nitric acid is one process step in the production of

	fertilisers containing nitrogen. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The dataset is applicable for production of nitric acid at Hydro Agri AB in Landskrona. The nitric acid production step is one step in the line of production of calcium ammonium nitrate (CAN) at the site in Landskrona. Nitric acid is neutralised with ammonia and mixed with dolomite to produce CAN. The dataset is included in the aggregated dataset for production of CAN fertiliser at Hydro Agri AB in Landskrona (cradle to gate).
About Data	Data are collected from the official environmental report distributed by Hydro Agri AB in Landskrona and also by contact with Ronnie Persson, Göte Bertilsson and Mats Karlsson, Hydro Agri AB in Landskrona.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of nonylphenol and dinonylphenol

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Production of nonylphenol and dinonylphenol
Functional Unit	ton
Functional Unit Explanation	1 ton maufactured nonylphenol and dinonylphenol. The annual production of 1996 was 8128 ton nonylphenole and dinonylphenole. The amount of the sepatate substances are not stated. The two substances is produced in the same process.
Process Type	Gate to gate
Site	Akzo Nobel, Surface Chemistry AB Ågatan 44 431 37 Möndal Sweden
Sector	Materials and components
Owner	Akzo Nobel, Surface Chemistry AB Ågatan 44 431 37 Möndal Sweden
Technical system description	Production of nonyl phenol and dinonyl phenol. Alkylphenols are produced with a chemical reaction between the substances nonen and phenol. The reaction is accelerated by the catalyst borontrifluoride. The production is done batch by batch in a reactor, in which the slightly exothermal reaction leaves the substances mono- and dinonylphenol together with the non reacted phenole and nonen. The phenole and nonen is then cupeled to be recycledin a oil heated boiler. The gases contain small amounts of different kinds of carbon hydrigenes, which are taken up by the pack watera of the vacuum pump or is cupeled to be destroyed in a conbustion heat exchanger. Dissolved phenol in the pack water is separated and neutralized with potassium lye.Water containing potassium phenolate and nonreacted is treated (destroyed) in Stenungsund eller by SAKAB. Through distillation nonyl phenol and dinonyl phenol is produced. The higher alkylphenols

	that are restpruducts from the distillation are mixed with the fuel oil to be conbusted in a steem-boiler or a oil heated boiler. The nonyl phenol and the dinonyl phenol are stored to be put on barrel or to be delivered by tank lorry. Emission to the air is caused by the energy production in the process of making nonylphenol. Diffuse emissions are also made from the stock of tanks. Carbon hydrogenes, from the cupel column and the distillation columns of the process, that are not condensed are led to a combustion exchanger. The exchanger consist of a bedding of gravel in a segregated holder. Electrical heating spirals are situated in the center, and they keep the contaminations burning. The air is cleansed to at least 90%. The gas is cupeled to the atmosphere by a smoke-stack. Substances are not normally emitted to water.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	N/A
Method	Study the environmental report The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1996, which was 8128 ton nonylphenole and dinonylphenole.
Literature Reference	Miljörapport (official environmental report) 1997, Hydro Agri AB, Box 516, 261 24 Landskrona, Sweden. Personal communication: Göte Bertilsson (1998), Hydro Agri AB Landskrona, tel. +46 418 76100 Ronnie Persson (1998), Hydro Agri AB Landskrona, tel +46 418 76100
Notes	The data type unspecified implies that one does not know the origin of the data. Information about the air emission is found under Specific QMetaData for SOx.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Borontrifluoride is used as a catalyst in the reaction between nonen and phenol	Input	Refined resource	Borontrifluoride	0.001058071			tonne	Technosphere	
	Input	Refined resource	Electricity	0.000207923			GWh	Technosphere	
Date concieved: 1996 Notes: Containing less than 0,1% S.	Input	Refined resource	Fuel oil	0.051181102			tonne	Technosphere	
Notes: Lubricating oil (SAE 40) for the vacuum pump.	Input	Refined resource	Lubricating oil	0.000184547			tonne	Technosphere	
Date concieved: 1996 Notes: The substance is added in the feed water.	Input	Refined resource	Mitco LB 2050	0.00000922736			tonne	Technosphere	

Date concieved: 1996 Notes: The substance is added in the feed water.	Input	Refined resource	Mitco R-10	0.00000307579			tonne	Technosphere	
	Input	Refined resource	Nonen	0.601870079			tonne	Technosphere	
	Input	Refined resource	Phenol	0.41449311			tonne	Technosphere	
Date concieved: 1996 Notes: The substance is a solvent	Input	Refined resource	Potashlye	0.001599409			tonne	Technosphere	
Date concieved: 1996 Notes: The substance is added in the feed water.	Input	Refined resource	Solvay salttabletter	0.000123031			tonne	Technosphere	
Date concieved: 1996 Notes: 99,4% of the water is used for cooling, and is taken from the Mölndalså. The used water is led back to the streem. The temperatur difference between outgoing and incoming water is 25°C. The rest of the water comes from the water purification plant. After use, if it is not contaminated, it is led to the Mölndalså through an oil seperater.	Input	Refined resource	Water	150.3			m3 fub	Technosphere	
	Output	Emission	Br	0.000000147638			tonne	Air	
	Output	Emission	Dust	0.0000615157			tonne	Air	
	Output	Emission	Fluoride	0.0000000123031			tonne	Air	
	Output	Emission	NOx	0.000492126			tonne	Air	
Date concieved: 1996 Notes: Emission to air occur from the combustion exchanger and the steamboiler.	Output	Emission	SOx	0.0000492126			tonne	Air	
	Output	Emission	VOC	0.000836614			tonne	Air	
Date concieved: 1996 Notes: Both of the two substances is produced.	Output	Product	Nonylphenol/Dinonylphenol	1			tonne	Technosphere	
Date concieved: 1996 Notes: The waste is dumped at Sävenäs.	Output	Residue	Household waste	0.000984252			m3	Technosphere	
Notes: The liquis nonen is transported by ADR and recieved by Site Stenungsund.	Output	Residue	Nonen	0.00825738192			tonne	Technosphere	
Date concieved: 1996 Notes: The rest products consist	Output	Residue	Other rest products	0.001107283			tonne	Technosphere	

of plastics, wood, glass and garden waste. The waste is dumped at the Kikåsdump									
Date concieved: 1996	Output	Residue	Waste paper	0.000541339			m3	Technosphere	
Notes: Consists of water (flush, process and rain water), nonylphenol, dinonylphenol, oil, products and raw material, and is transported by RECI (Skaraborgs miljötransporter) and recieved by SAKAB.	Output	Residue	Waste water	0.0056311875			tonne	Technosphere	
Notes: Consists of water, nonylphenol, dinonylphenol and oil and is transported by ADR and recieved by Site Stenungsund.	Output	Residue	Waste water	0.0208063125			tonne	Technosphere	

About Inventory	
Publication	The environmental report from Akzo Nobel Surface Chemistry AB for 1996. The Environmental Administration in the municipality of Göteborg, Sweden -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	- Akzo Nobel, Surface Chemistry AB Ågatan 44 431 37 Möndal Sweden .
Reviewer	Billstedt L, Bording H - Akzo Nobel, Surface Chemistry AB Ågatan 44 431 37 Möndal Sweden
Applicability	
About Data	No margin of error is found in the report, and one can assume that a lot of values have been rounded. The plant has during 1996 been in operation 8100 h.
Notes	

SPINE LCI dataset: Production of NP 27-5 fertiliser

Administrative	
Finished	Y
Date Completed	1999-01-25
Copyright	

Availability	Public (confidential energy flow data are not included).

Technical System

Name	Production of NP 27-5 fertiliser
Functional Unit	1 kg of NP 27-5 fertiliser
Functional Unit Explanation	1 kg of Hydro NP Svavel 27-5, uncoated and unpacked. 27 % N and 5 % P.
Process Type	Gate to gate
Site	Hydro Agri AB Box 908 SE-731 29 Köping Sweden
Sector	Materials and components
Owner	Hydro Agri AB Box 908 SE-731 29 Köping Sweden
Technical system description	At the plant operated by Hydro Agri AB in Köping, NP 27-5 fertiliser is produced by the mixed acid route as follows: Ammonium nitrate is mixed with dolomite, phosphoric acid, ammonia and ammonium sulphate. The neutralisation with ammonia yields heat. The slurry is granulated, dried in a rotary drier, sifted, cooled and sifted again before final coating and storing.

System Boundaries

Nature Boundary	The system is a gate to gate system, it starts at the incoming factory gate and ends at the outgoing factory gate. Production of steam, electricity and input materials are outside the system boundary.
Time Boundary	The data are figures for production in 1997.
Geographical Boundary	Hydro Agri AB in Köping, Sweden.
Other Boundaries	Coatings, micronutrient and small additives have not been taken into account. Packaging of fertiliser has also been left outside the system boundary. Production and waste treatment of catalysts and production of capital goods are not included.
Allocations	Several different fertiliser products are produced at the Hydro Agri plant in Köping. Concerning consumption of energy and emissions of particulates to air, these have been allocated to the different products by mass of the products. Emissions of nitrogen to water and ammonia to air have been allocated to the different products by their mass content of nitrogen. Emissions of phosphorus to water heve been allocated according to mass content of phosphorus in the products.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	N/A
Method	The data are gathered from the official environmental report distributed by Hydro Agri AB in Köping and also from personal communication with people working there. Several different fertiliser products are produced at the Hydro Agri plant in Köping. Concerning consumption of energy and emissions of particulates to air, these have been allocated to the different products by mass of the products. Emissions of nitrogen to water and ammonia to air have been allocated to the different products by their mass content of nitrogen. Emissions of phosphorus to water heve been allocated according to mass content of phosphorus in the products.
Literature Reference	Miljörapport Hydro Agri AB Köping, (1998). Official environmental report. Hydro Agri AB, Box 908, 731 29 Köping. Personal communication: Andersson B (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27834. Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Karlsson L-H (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27800
Notes	Energy flow data are confidential.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: The ammonia used in fertiliser production in Sweden originates from Poland or Russia (bought from spot market in the Baltic sea)	Input	Refined resource	Ammonia	0.0241			kg	Technosphere	Sweden

Notes: Produced at the Hydro Agri plant in Köping.	Input	Refined resource	Ammonium nitrate	0.64			kg	Technosphere	Sweden
Notes: By-product from production of Caprolactam. Imported from The Czech Republic.	Input	Refined resource	Ammonium sulphate	0.124			kg	Technosphere	Sweden
Notes: Ground dolomite.	Input	Refined resource	Dolomite	0.0607			kg	Technosphere	Sweden
Notes: Confidential.	Input	Refined resource	Electricity				MJ	Technosphere	Sweden
Notes: 43 % P (The imported phosphoric acid contains 55,5 % P2O5 = 24,22 % P, the evaporation is included in the consumption of energy). Imported from Finland.	Input	Refined resource	Phosphoric acid	0.11			kg	Technosphere	Sweden
Notes: Confidential.	Input	Refined resource	Steam				MJ	Technosphere	Sweden
	Output	Emission	NH3	0.2			g	Air	Sweden
	Output	Emission	N-tot	0.0363			g	Water	Sweden
	Output	Emission	Particles	0.0178			g	Air	Sweden
	Output	Emission	P-tot	0.00190			g	Water	Sweden
Notes: Hydro NP Svavel 27-5; 27 % N and 5 % P.	Output	Product	NPK fertiliser	1			kg	Technosphere	Sweden

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources due to the production of fertilisers used in Sweden and Western Europe.
Detailed Purpose	The purpose was not to compare production of different fertilisers with each other, but to generate a thorough inventory of emissions and use of resources due to this production. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The data are applicable for production of NP 27-5 fertiliser that is produced and used in Sweden. It can be assumed that the data are representative for all the NP 27-5 used in Sweden, but it is important to be aware of the fact that there may exist imports of NPK 27-5 into Sweden. However, it is likely that the NP 27-5 used in Sweden originates from Swedish production. The dataset is included in the aggregated dataset for production of NP 27-5 at Hydro Agri AB in Köping (cradle to gate).
About Data	The data are taken from a specific site in Sweden and are therefore reliable. The data are gathered from the official environmental report distributed by Hydro Agri AB in Köping and also from personal communication with people working there. There is only one plant in Sweden that produces NPK fertilisers and the data are therefore representative for Swedish production of NP 27-5.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of NP 27-5 fertiliser AGGR

Flow Chart

This data set transparently reported, including a flowchart where each process is individually described

Administrative	
Finished	Y
Date Completed	1999
Copyright	
Availability	

Technical System	
Name	Production of NP 27-5 fertiliser AGGR
Functional Unit	1 kg NPK fertiliser
Functional Unit Explanation	
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The production route of NP 27-5 fertiliser produced at Hydro Agri AB in Köping can be seen in the aggregated activity window. For information about each separate production step, please see each included dataset. Emissions from transports, energy consumption and production of steam, district heat and electricity have been included in the system by using information and emission factors from the database in LCAiT 3.0. LCAiT 3.0 is a computer programme created by CIT Ekologik in Gothenburg for practitioners of life cycle assessments. Production/consumption of steam is assumed to replace/be produced by combustion of oil (efficiency of 0.90). Oil has been chosen as fuel source, as it in terms of emissions lies between coal and natural gas. Included transports and assumptions made regarding transports are described below (transports cannot be seen in the aggregated activity window). Ammonia: The ammonia used in production of fertilisers in Sweden is purchased at the spot market in the Baltic Sea. This ammonia mostly originates from Russia and Poland. The ammonia has been assumed to origin from the area around Moscow. It has been assumed that the ammonia is transported by train from Moscow to the harbour in Ventspils in Latvia (1000 km, train, diesel) and then transported by boat to Köping (700 km, ship, bulk carrier). Pyrite: The pyrite used for production of phosphoric acid in Siilinjärvi, Finland, is mined in Outokumpu, Finland, and transported by truck (90 km, medium truck, rural, full) to Siilinjärvi. Rock phosphate: The rock phosphate is mined nearby Siilinjärvi and no transportation has therefore been included for this material. Phosphoric acid: The phosphoric acid used at Hydro Agri AB in Köping is then transported from Siilinjärvi to Köping by two different routes. Phosphoric acid with a concentration of 58 % P2O5 is transported from Siilinjärvi by train (300 km, train, diesel) to Kokkola and then by boat (400 km, ship, bulk carrier) via Uusikapuuki to Köping. Phosphoric acid with a concentration of 52 % P2O5 is transported from Siilinjärvi by train (540 km, train, diesel) to Uuskapuuki and then by boat (300 km, ship, bulk carrier) on to Köping. The concentration of phosphoric acid used in Köping is 55-56 % P2O5 and a concentration of 55.5 % has been assumed. This acid is a blend of the two acids, and consequently, 58 % are taken by train and boat to Uuskikapuuki and 42 % are taken by train to Uuskikapuuki. Dolomite: The dolomite used at Hydro Agri AB in Köping is transported by truck (55 km, medium truck, rural, full) to Köping. Ammonium sulphate (by-product from production of caprolactam and has therefore only been charged with transport): The ammonium sulphate is taken from the Czech Republic. During two thirds of the year it is transported via Lübeck and during one third via Gdansk in Poland. By the first route it is transported from north of Prague to Lübeck by barge (520 km, ship, coaster) and then on

	to Köping by boat (1000 km, ship, bulk carrier). On the second route, the ammonium sulphate is transported by train (500 km, train, diesel) from north of Prague to Gdansk. From Gdansk it is transported by boat (750 km, ship, bulk carrier) to Köping.

Flowchart

Click on flowchart to open each data set description

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	N/A
Method	The data are gathered from the official environmental report distributed by Hydro Agri AB in Köping and also from personal communication with people working there. Several different fertiliser products are produced at the Hydro Agri plant in Köping. Concerning consumption of energy and emissions of particulates to air, these have been allocated to the different products by mass of the products. Emissions of nitrogen to water and ammonia to air have been allocated to the different products by their mass content of nitrogen. Emissions of phosphorus to water heve been allocated according to mass content of phosphorus in the products.
Literature Reference	Miljörapport Hydro Agri AB Köping, (1998). Official environmental report. Hydro Agri AB, Box 908, 731 29 Köping. Personal communication: Andersson B (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27834. Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Karlsson L-H (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27800
Notes	Energy flow data are confidential.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Dolomite	0.0607			kg	Ground	
Notes: Emissions from extraction and final use (combustion) of hard coal are included in the outputs.	Input	Natural resource	Hard coal	1.17E+00			MJ	Ground	
Notes: >100 kW. Emissions from extraction and final use (combustion) of natural gas are included in the outputs.	Input	Natural resource	Natural gas	9.36E+00			MJ	Ground	
Notes: Emissions from extraction and final use (combustion) of oil are included in the outputs.	Input	Natural resource	Oil, heavy fuel	1.86E+00			MJ	Ground	
	Input	Natural resource	Phosphorus	0.048			kg	Ground	
Notes: Emissions from production and final use (combustion) of diesel are included in the outputs.	Input	Refined resource	Diesel	4.07E-01			MJ	Technosphere	
Notes: ''Negative'' emissions from avoided production of district heat are included in the outputs.	Input	Refined resource	District heat	-9.88E-01			MJ	Technosphere	Sweden
Notes: Emissions from production of electricity are included in the outputs.	Input	Refined resource	Electricity	2.16E-01			MJ	Technosphere	Europe
Notes: Emissions from production of electricity are included in the outputs.	Input	Refined resource	Electricity	3.06E-01			MJ	Technosphere	Sweden

Notes: Emissions from extraction and final use (combustion) of fuel oil are included in the outputs.	Input	Refined resource	Fuel oil, ship (2-stroke)	2.25E-02			MJ	Technosphere	
	Output	Emission	Acetaldehyde	9.36E-06			g	Air	
	Output	Emission	Acetylene	5.39E-04			g	Air	
	Output	Emission	Al	3.74E-04			g	Air	
	Output	Emission	Aldehydes	1.67E-06			g	Air	
	Output	Emission	Alkanes	1.54E-03			g	Air	
	Output	Emission	Alkenes	5.90E-04			g	Air	
Notes: (C9-C10)	Output	Emission	Aromates	2.93E-04			g	Air	
Notes: (C9-C10)	Output	Emission	Aromates	8.09E-06			g	Water	
	Output	Emission	As	7.12E-06			g	Water	
	Output	Emission	As	9.09E-05			g	Air	
	Output	Emission	B	2.97E-04			g	Air	
	Output	Emission	Be	8.17E-06			g	Air	
	Output	Emission	Benzene	5.77E-03			g	Air	
	Output	Emission	Benzo(a)pyrene	1.64E-07			g	Air	
	Output	Emission	BOD	3.85E-05			g	Water	
	Output	Emission	Butane	6.50E-03			g	Air	
	Output	Emission	Ca	1.48E-04			g	Air	
	Output	Emission	Cd	3.51E-06			g	Water	
	Output	Emission	Cd	8.36E-05			g	Air	
	Output	Emission	CH4	9.25E-01			g	Air	
	Output	Emission	Cl-	2.58E+00			g	Water	
	Output	Emission	CN-	1.52E-05			g	Air	
	Output	Emission	CN-	2.52E-06			g	Water	
	Output	Emission	Co	1.78E-04			g	Air	
	Output	Emission	CO	2.18E-01			g	Air	
	Output	Emission	Co	6.44E-07			g	Water	
	Output	Emission	CO2	9.03E+02			g	Air	
	Output	Emission	COD	1.11E-03			g	Water	
	Output	Emission	Cr	5.13E-04			g	Air	
	Output	Emission	Cr	7.95E-06			g	Water	
	Output	Emission	Cr3+	-2.84E-05			g	Air	
	Output	Emission	Cr3+	4.37E-05			g	Water	
	Output	Emission	Cu	1.83E-06			g	Water	
	Output	Emission	Cu	4.78E-04			g	Air	
	Output	Emission	Dioxin	2.74E-10			g	Air	
	Output	Emission	Dissolved solids	4.32E-02			g	Water	
	Output	Emission	DOC	3.01E-13			g	Water	
	Output	Emission	Ethane	1.62E-03			g	Air	
	Output	Emission	Ethene	3.24E-03			g	Air	
	Output	Emission	F-	7.87E-04			g	Water	
	Output	Emission	Fe	1.22E-02			g	Water	
	Output	Emission	Fe	3.34E-04			g	Air	
	Output	Emission	Formaldehyde	1.85E-03			g	Air	
	Output	Emission	F-tot	2.60E-02			g	Air	
	Output	Emission	H+	3.31E-05			g	Water	
	Output	Emission	H2S	1.34E-05			g	Air	
	Output	Emission	H2S	8.27E-08			g	Water	
	Output	Emission	Hazardous waste	7.12E+01			g	Technosphere	
	Output	Emission	HC	2.45E-05			g	Water	
	Output	Emission	HCl	5.98E-02			g	Air	
	Output	Emission	Heavy metals	7.14E-19			g	Air	
	Output	Emission	HF	3.19E-03			g	Air	
	Output	Emission	Hg	5.01E-06			g	Air	
	Output	Emission	Highly active rad ac waste	8.06E-03			g	Technosphere	
	Output	Emission	Industrial waste	5.42E+02			g	Technosphere	
	Output	Emission	Metals	1.11E-06			g	Air	
	Output	Emission	Metals	5.51E-06			g	Water	
	Output	Emission	Mn	4.45E-04			g	Air	
	Output	Emission	Mn	4.56E-05			g	Water	
	Output	Emission	Mo	1.31E-04			g	Air	
	Output	Emission	N2O	4.56E+00			g	Air	
	Output	Emission	Na	1.39E-03			g	Air	

	Output	Emission	NH3	1.99E-08			g	Water	
	Output	Emission	NH3	2.00E-01			g	Air	
	Output	Emission	Ni	1.90E-03			g	Air	
	Output	Emission	Ni	2.56E-05			g	Water	
	Output	Emission	NMVOC	5.47E-01			g	Air	
	Output	Emission	NO2	5.09E-01			g	Air	
	Output	Emission	NOx	1.83E+00			g	Air	
	Output	Emission	N-tot	1.06E-01			g	Water	
	Output	Emission	Oil	5.84E-02			g	Water	
	Output	Emission	Organics	3.32E-06			g	Air	
	Output	Emission	Organics	4.77E-02			g	Water	
	Output	Emission	PAH	9.45E-05			g	Air	
	Output	Emission	Particulates	2.71E-01			g	Air	
	Output	Emission	Pb	2.61E-05			g	Water	
	Output	Emission	Pb	4.10E-04			g	Air	
	Output	Emission	Pentane	1.11E-02			g	Air	
	Output	Emission	Phenol	7.51E-15			g	Water	
	Output	Emission	Phosphate	2.52E-05			g	Water	
	Output	Emission	PO43-	1.55E-04			g	Water	
	Output	Emission	Propane	2.99E-03			g	Air	
	Output	Emission	Propene	5.34E-04			g	Air	
	Output	Emission	P-tot	1.90E-03			g	Water	
	Output	Emission	Radioactive emissions	-3.04E+03			kBq	Water	
	Output	Emission	Radioactive emissions	-3.24E+05			kBq	Air	
	Output	Emission	Radioactive waste	2.47E-03			g	Technosphere	
	Output	Emission	Rn-222	2.34E+03			Bq	Air	
	Output	Emission	Salt	3.10E-02			g	Water	
	Output	Emission	Sb	5.27E-05			g	Air	
	Output	Emission	Sb	9.04E-09			g	Water	
	Output	Emission	Se	6.82E-05			g	Air	
	Output	Emission	Sn	4.97E-04			g	Water	
	Output	Emission	Sn	6.77E-08			g	Air	
	Output	Emission	SO2	3.11E+00			g	Air	
	Output	Emission	SO3	8.99E-02			g	Air	
	Output	Emission	SO42-	1.73E-01			g	Water	
	Output	Emission	Solid waste	1.90E+03			g	Technosphere	
	Output	Emission	Sr	2.15E-04			g	Water	
	Output	Emission	Sr	3.04E-06			g	Air	
	Output	Emission	Susp solids	7.06E-04			g	Water	
	Output	Emission	Th	4.84E-08			g	Air	
	Output	Emission	Tl	8.35E-09			g	Air	
	Output	Emission	Toluene	2.02E-03			g	Air	
	Output	Emission	U	4.65E-08			g	Air	
	Output	Emission	V	2.12E-06			g	Water	
	Output	Emission	V	5.26E-03			g	Air	
	Output	Emission	VOC	1.06E-02			g	Air	
	Output	Emission	Xylene	1.09E-04			g	Air	
	Output	Emission	Zn	4.46E-05			g	Water	
	Output	Emission	Zn	5.18E-04			g	Air	
Notes: Hydro NP Svavel 27-5, uncoated and unpacked. 27 % N and 5 % P (percentage by weight).	Output	Product	NPK fertiliser	1			kg	Technosphere	

About Inventory	
Publication	
Intended User	
General Purpose	
Detailed Purpose	
Commissioner	

Practitioner	
Reviewer	
Applicability	
About Data	
Notes	

SPINE LCI dataset: Production of NPK 20-3-5 fertiliser

Administrative	
Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public (energy flow data are confidential and not included).

Technical System	
Name	Production of NPK 20-3-5 fertiliser
Functional Unit	1 kg of NPK 20-3-5 fertiliser
Functional Unit Explanation	1 kg of Hydro NPK Svavel Bor 20-3-5, unpacked and uncoated. 20 % N, 3 % P och 5 % K
Process Type	Gate to gate
Site	Hydro Agri AB Box 908 SE-731 29 Köping Sweden
Sector	Materials and components
Owner	Hydro Agri AB Box 908 SE-731 29 Köping Sweden
Technical system description	At the plant operated by Hydro Agri AB in Köping, NPK 20-3-5 fertiliser is produced by the mixed acid route as follows: Ammonium nitrate is mixed with dolomite, potassium chloride, phosphoric acid and ammonia and kieserite. The neutralisation with ammonia yields heat. The slurry is granulated, dried in a rotary drier, sifted, cooled and sifted again before final coating and storing.

System Boundaries	
Nature Boundary	The system is a gate to gate system, it starts at the incoming factory gate and ends at the outgoing factory gate. Production of steam, electricity and input materials are not included in the system boundary.
Time Boundary	The data are taken from production in 1997.
Geographical Boundary	Hydro Agri AB in Köping, Sweden.
Other Boundaries	Coatings, micronutrient and small additives are not included in the system. Packaging of fertiliser has also been left outside the system boundary. Production and waste treatment of catalysts and production of capital goods are not included.
Allocations	Several different fertiliser products are produced at the Hydro Agri plant in Köping. Concerning consumption of energy and emissions of particulates to air, these have been allocated to the different products by mass of the products. Emissions of nitrogen to water and ammonia to air have been allocated to the different products by their mass content of nitrogen. Emissions of phosphorus to water heve been allocated according to mass content of phosphorus in the products.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	N/A
Method	Data are gathered from the official environmental report distributed by Hydro Agri AB in Köping and also from personal communication with people working there.
Literature Reference	Miljörapport Hydro Agri AB Köping, (1998). Official environmental report. Hydro Agri AB, Box 908, 731 29 Köping. Personal communication: Andersson B (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27834. Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Karlsson L-H (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27800
Notes	Energy figures are confidential.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: The ammonia used in fertiliser production in Sweden originates from Russia or Poland (bought from spot market in the Baltic sea)	Input	Refined resource	Ammonia	0.016			kg	Technosphere	Sweden
Notes: Produced at the Hydro plant in Köping	Input	Refined resource	Ammonium nitrate	0.531			kg	Technosphere	Sweden
Notes: From Sala Mineraler AB	Input	Refined resource	Dolomite	0.0857			kg	Technosphere	Sweden
Notes: Confidential.	Input	Refined resource	Electricity				MJ	Technosphere	Sweden
Notes: Imported from Germany.	Input	Refined resource	Kieserite	0.148			kg	Technosphere	Sweden
Notes: 43 % P. Imported from Finland.	Input	Refined resource	Phosphoric acid	0.07			kg	Technosphere	Sweden
Notes: Imported from Germany.	Input	Refined resource	Potassium chloride	0.077			kg	Technosphere	Sweden
Notes: Confidential.	Input	Refined resource	Steam				MJ	Technosphere	Sweden
	Output	Emission	NH3	0.148			g	Air	Sweden
	Output	Emission	N-tot	0.0269			g	Water	Sweden
	Output	Emission	Particles	0.0178			g	Air	Sweden
	Output	Emission	P-tot	0.00119			g	Water	Sweden
Notes: Hydro NPK Svavel Bor 20-3-5; 20 % N, 3 % P and 5 % K	Output	Product	NPK fertiliser	1			kg	Technosphere	Sweden

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources due to the production of fertilisers used in Sweden and Western Europe.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other but to generate a thorough inventory of emissions and use of resources due to this production. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The data are applicable for production of NPK 20-3-5 fertiliser that is produced and used in Sweden. It can be assumed that the data are representative for all the NPK 20-3-5 used in Sweden, but it is important to be aware of the fact that there may exist imports of NPK 20-3-5 into Sweden. However, it is likely that the NPK 20-3-5 used in Sweden originates from Swedish production.

About Data	The data are taken from a specific site in Sweden and are therefore reliable. The data are gathered from the official environmental report distributed by Hydro Agri AB in Köping and also from personal communication with people working there. There is only one plant in Sweden that produces NPK fertilisers and the data are therefore representative for Swedish production of NPK 20-3-5.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of NPK 20-3-5 fertiliser AGGR

Flow Chart

This data set transparently reported, including a flowchart where each process is individually described

Administrative	
Finished	Y
Date Completed	1999
Copyright	
Availability	

Technical System	
Name	Production of NPK 20-3-5 fertiliser AGGR
Functional Unit	1 kg NPK fertiliser
Functional Unit Explanation	
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The production route of NPK 20-3-5 fertiliser produced at Hydro Agri AB in Köping can be seen in the aggregated activity window. For information about each separate production step, please see each included dataset. Emissions from transports, energy consumption and production of steam, district heat and electricity have been included in the system by using information and emission factors from the database in LCAiT 3.0. LCAiT 3.0 is a computer programme created by CIT Ekologik in Gothenburg for practitioners of life cycle assessments. Production/consumption of steam is assumed to replace/be produced by combustion of oil (efficiency of 0.90). Oil has been chosen as fuel source, as it in terms of emissions lies between coal and natural gas. Included transports and assumptions made regarding transports are described below (transports cannot be seen in the aggregated activity window). Ammonia The ammonia used in production of fertilisers in Sweden is purchased at the spot market in the Baltic Sea. This ammonia mostly originates from Russia and Poland. The ammonia has been assumed to origin from the area around Moscow. It has been assumed that the ammonia is transported by train from Moscow to the harbour in Ventspils in Latvia (1000 km, train, diesel) and then transported by boat to Köping (700 km, ship, bulk carrier). Pyrite The pyrite used for production of phosphoric acid in Siilinjärvi, Finland, is mined in Outokumpu, Finland, and transported by truck (90 km, medium truck, rural, full) to Siilinjärvi. Rock phosphate The rock phosphate is taken nearby Siilinjärvi and no transportation has therefore been included for this material. Phosphoric acid The phosphoric acid used at Hydro Agri AB in Köping is then transported from Siilinjärvi to Köping by two different routes. Phosphoric acid with a concentration of 58 % P2O5 is

	transported from Siilinjärvi by train (300 km, train, diesel) to Kokkola and then by boat (400 km, ship, bulk carrier) via Uusikapuuki to Köping. Phosphoric acid with a concentration of 52 % P2O5 is transported from Siilinjärvi by train (540 km, train, diesel) to Uuskapuuki and then by boat (300 km, ship, bulk carrier) on to Köping. The concentration of phosphoric acid used in Köping is 55-56 % P2O5 and a concentration of 55.5 % has been assumed. This acid is a blend of the two acids, and consequently, 58 % are taken by train and boat to Uuskikapuuki and 42 % are taken by train to Uuskikapuuki. Potassium chloride and kieserite The potassium chloride and kieserite used for production of fertilisers at Hydro Agri AB in Köping is mostly taken from the Werra region in Germany. It has been assumed that all the potassium chloride and Kieserite is transported from this region by train (380 km, train, diesel) to Wismar (Germany). From Wismar the materials are transported by boat (980 km, ship, bulk carrier) to Köping. Dolomite The dolomite used at Hydro Agri AB in Köping is transported by truck (55 km, medium truck, rural, full) to Köping.

Flowchart
Click on flowchart to open each data set description

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	N/A
Method	Data are gathered from the official environmental report distributed by Hydro Agri AB in Köping and also from personal communication with people working there.
Literature Reference	Miljörapport Hydro Agri AB Köping, (1998). Official environmental report. Hydro Agri AB, Box 908, 731 29 Köping. Personal communication: Andersson B (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27834. Bertilsson G (1998). Hydro Agri AB, Landskrona. Tel. +46 (0)418 76100 Karlsson L-H (1998). Hydro Agri AB, Köping. Tel. +46 (0)221 27800
Notes	Energy figures are confidential.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Dolomite	0.0857			kg	Ground	Sweden
Notes: Emissions from extraction and final use (combustion) of hard coal are included in the outputs.	Input	Natural resource	Hard coal	9.53E-01			MJ	Ground	
	Input	Natural resource	Kieserite	0.148			kg	Ground	
Notes: (>100 kW). Emissions from extraction and final use (combustion) of natural gas are included inthe outputs.	Input	Natural resource	Natural gas	7.92E+00			MJ	Ground	
Notes: Emissions from extraction and final use (combustion) of oil, heavy fuel are included in the outputs.	Input	Natural resource	Oil, heavy fuel	1.48E+00			MJ	Ground	
	Input	Natural resource	Phosphorus	0.03			kg	Ground	
	Input	Natural resource	Potassium chloride	0.077			kg	Ground	

Notes: Emissions from production and final use (combustion) of diesel are included in the outputs.	Input	Refined resource	Diesel	3.45E-01			MJ	Technosphere	
Notes: ''Negative emissions'' from avoided production of district heat are included in the outputs.	Input	Refined resource	District heat	-8.21E-01			MJ	Technosphere	Sweden
Notes: Emissions from production of electricity are included in the outputs.	Input	Refined resource	Electricity	1.54E-01			MJ	Technosphere	Europe
Notes: Emissions from production of electricity are included in the outputs.	Input	Refined resource	Electricity	2.87E-01			MJ	Technosphere	Sweden
Notes: Emissions from production and final use (combustion) of fuel oil, ship are included in the outputs.	Input	Refined resource	Fuel oil, ship (2-stroke)	2.39E-02			MJ	Technosphere	
	Output	Emission	Acetaldehyde	7.92E-06			g	Air	
	Output	Emission	Acetylene	4.39E-04			g	Air	
	Output	Emission	Al	3.16E-04			g	Air	
	Output	Emission	Aldehydes	1.34E-06			g	Air	
	Output	Emission	Alkanes	1.23E-03			g	Air	
	Output	Emission	Alkenes	4.80E-04			g	Air	
Notes: (C9-C10)	Output	Emission	Aromates	2.33E-04			g	Air	
Notes: (C9-C10)	Output	Emission	Aromates	6.45E-06			g	Water	
	Output	Emission	As	5.71E-06			g	Water	
	Output	Emission	As	7.36E-05			g	Air	
	Output	Emission	B	2.11E-04			g	Air	
	Output	Emission	Be	6.67E-06			g	Air	
	Output	Emission	Benzene	4.80E-03			g	Air	
	Output	Emission	Benzo(a)pyrene	1.36E-07			g	Air	
	Output	Emission	BOD	3.27E-05			g	Water	
	Output	Emission	Butane	5.50E-03			g	Air	
	Output	Emission	Ca	1.18E-04			g	Air	
	Output	Emission	Cd	2.81E-06			g	Water	
	Output	Emission	Cd	6.69E-05			g	Air	
	Output	Emission	CH4	7.46E-01			g	Air	
	Output	Emission	Cl-	2.08E+00			g	Water	
	Output	Emission	CN-	1.21E-05			g	Air	
	Output	Emission	CN-	2.14E-06			g	Water	
	Output	Emission	Co	1.44E-04			g	Air	
	Output	Emission	CO	1.76E-01			g	Air	
	Output	Emission	Co	5.45E-07			g	Water	
	Output	Emission	CO2	7.49E+02			g	Air	
	Output	Emission	COD	9.43E-04			g	Water	
	Output	Emission	Cr	4.19E-04			g	Air	
	Output	Emission	Cr	6.73E-06			g	Water	
	Output	Emission	Cr3+	-2.39E-05			g	Air	
	Output	Emission	Cr3+	3.47E-05			g	Water	
	Output	Emission	Cu	1.56E-06			g	Water	
	Output	Emission	Cu	3.88E-04			g	Air	
	Output	Emission	Dioxin	2.19E-10			g	Air	
	Output	Emission	Dissolved solids	3.47E-02			g	Water	
	Output	Emission	DOC	2.41E-13			g	Water	
	Output	Emission	Ethane	1.32E-03			g	Air	
	Output	Emission	Ethene	2.64E-03			g	Air	
	Output	Emission	F-	6.28E-04			g	Water	
	Output	Emission	Fe	2.66E-04			g	Air	
	Output	Emission	Fe	8.65E-03			g	Water	
	Output	Emission	Formaldehyde	1.52E-03			g	Air	
	Output	Emission	F-tot	1.65E-02			g	Air	
	Output	Emission	H+	2.66E-05			g	Water	
	Output	Emission	H2S	1.08E-05			g	Air	
	Output	Emission	H2S	7.00E-08			g	Water	
	Output	Emission	Hazardous waste	6.01E+01			g	Technosphere	
	Output	Emission	HC	1.94E-05			g	Water	
	Output	Emission	HCl	4.85E-02			g	Air	
	Output	Emission	Heavy metals	5.06E-19			g	Air	
	Output	Emission	HF	2.58E-03			g	Air	

	Output	Emission	Hg	3.92E-06			g	Air	
	Output	Emission	Highly active rad ac waste	5.68E-03			g	Technosphere	
	Output	Emission	Industrial waste	4.57E+02			g	Technosphere	
	Output	Emission	Metals	4.43E-06			g	Water	
	Output	Emission	Metals	8.85E-07			g	Air	
	Output	Emission	Mn	3.63E-04			g	Air	
	Output	Emission	Mn	3.67E-05			g	Water	
	Output	Emission	Mo	1.06E-04			g	Air	
	Output	Emission	N2O	3.79E+00			g	Air	
	Output	Emission	Na	1.11E-03			g	Air	
	Output	Emission	NH3	1.48E-01			g	Air	
	Output	Emission	NH3	1.87E-08			g	Water	
	Output	Emission	Ni	1.52E-03			g	Air	
	Output	Emission	Ni	2.05E-05			g	Water	
	Output	Emission	NMVOC	4.41E-01			g	Air	
	Output	Emission	NO2	4.22E-01			g	Air	
	Output	Emission	NOx	1.50E+00			g	Air	
	Output	Emission	N-tot	8.41E-02			g	Water	
	Output	Emission	Oil	4.69E-02			g	Water	
	Output	Emission	Organics	2.68E-06			g	Air	
	Output	Emission	Organics	3.84E-02			g	Water	
	Output	Emission	PAH	7.99E-05			g	Air	
	Output	Emission	Particulates	2.28E-01			g	Air	
	Output	Emission	Pb	2.09E-05			g	Water	
	Output	Emission	Pb	3.32E-04			g	Air	
	Output	Emission	Pentane	9.42E-03			g	Air	
	Output	Emission	Phenol	6.03E-15			g	Water	
	Output	Emission	Phosphate	2.14E-05			g	Water	
	Output	Emission	PO43-	1.23E-04			g	Water	
	Output	Emission	Propane	2.49E-03			g	Air	
	Output	Emission	Propene	4.35E-04			g	Air	
	Output	Emission	P-tot	1.19E-03			g	Water	
	Output	Emission	Radioactive emissions	-2.53E+03			kBq	Water	
	Output	Emission	Radioactive emissions	-2.69E+05			kBq	Air	
	Output	Emission	Radioactive waste	1.80E-03			g	Technosphere	
	Output	Emission	Rn-222	2.39E+03			Bq	Air	
	Output	Emission	Salt	2.24E-02			g	Water	
	Output	Emission	Sb	4.29E-05			g	Air	
	Output	Emission	Sb	7.66E-09			g	Water	
	Output	Emission	Se	5.47E-05			g	Air	
	Output	Emission	Sn	4.24E-04			g	Water	
	Output	Emission	Sn	4.81E-08			g	Air	
	Output	Emission	SO2	2.23E+00			g	Air	
	Output	Emission	SO3	5.72E-02			g	Air	
	Output	Emission	SO42-	1.31E-01			g	Water	
	Output	Emission	Solid waste	1.20E+03			g	Technosphere	
	Output	Emission	Sr	1.72E-04			g	Water	
	Output	Emission	Sr	2.16E-06			g	Air	
	Output	Emission	Susp solids	5.66E-04			g	Water	
	Output	Emission	Th	3.44E-08			g	Air	
	Output	Emission	Tl	5.93E-09			g	Air	
	Output	Emission	Toluene	1.70E-03			g	Air	
	Output	Emission	U	3.30E-08			g	Air	
	Output	Emission	V	1.79E-06			g	Water	
	Output	Emission	V	4.19E-03			g	Air	
	Output	Emission	VOC	8.68E-03			g	Air	
	Output	Emission	Xylene	8.88E-05			g	Air	
	Output	Emission	Zn	3.38E-05			g	Water	
	Output	Emission	Zn	4.21E-04			g	Air	
Notes: Hydro NPK Svavel Bor 20-3-5, unpacked and uncoated. 20 % N, 3 % P och 5 % K	Output	Product	NPK fertiliser	1			kg	Technosphere	

About Inventory

Publication	
Intended User	
General Purpose	
Detailed Purpose	
Commissioner	
Practitioner	
Reviewer	
Applicability	
About Data	
Notes	

SPINE LCI dataset: Production of nylon 66 (APME)

Administrative

Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System

Name	Production of nylon 66 (APME)
Functional Unit	1 kg of nylon 66 (PA 66)
Functional Unit Explanation	The polyamids (PA´s) are a group of polymers characterised by a carbon chain with -CO-NH- groups interspersed at regular intervals along it. They are commonly referred to by the generic name nylon and may be produced by the direct polymerisation of amino-acids or by the reaction of a diamine with a dibasic acid. PA 66 stands for polyamid with two monomers, adipin acid with 6 carbon atoms, and hexamethylene diamine with 6 carbon atoms. Typical uses for polyamids are: cable ties, lighter bodies, radiator end tanks, air intake manifolds, covers of various types, wheel covers, throttle bodies, clips, fasteners, ski bindings, switchgear, circuit breakers and electrical/electronic components
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Nylon may be produced by the direct polymerisation of amino-acids or by the reaction of a diamine with a dibasic acid. The essential precursors for nylon 66 are hexamethylene diamine, and adipic acid. When they are reacted they produce hexamethylene diammonium adipate, commonly referred to as nylon salt. For fibre applications, it is important to ensure that the precursors are reacted in equimolar proportions and that the product is highly purified. The formation, extraction and purification of the salt ensures that these conditions are met. Adipic acid is made by the oxidation of cyclohexane to a mixture of cyclohexanol and

	cyclohexanone (called KA oil). This mixture is further oxidised with nitric acid to adipic acid. Hexamethylene diamine is made by the reduction of adiponitrile, which is made either by the electronic coupling of acrylonitrile or by the hydrocyanation of butadiene. Adipic acid and hexamethylene diamine are combined in water to make a salt solution. This solution is then passed through a batch or continous reactor in which the water is removed at high temperature and the nylon polymerises. The polymer is expelled from the reactor and granulated. Higher molecular weights are compounding of the the nylon with the modifiers or reinforcements. In some cases, it is possible to compound directly at the reactor without granulating the nylon. The results here refer to nylon66 containing 30% glass fibre. Operating conditions: As the data are based on information from 14 plants in 6 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 3 Nylon 66 producers in Germany and France. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 3 Nylon 66 production plants in 2 countries: France and Germany. Their total production was 28 000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene,

	propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, mixed
Represents	N/A
Method	European average data. Results are based on data supplied by 3 Nylon 66 production plants in 2 countries: France and Germany. Their total production was 28 000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports/htm/alphabetical.htm
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Air	1392776.28248345			mg	Air	Europe
	Input	Natural resource	Barytes	8.934835633763933			mg	Ground	Europe
	Input	Natural resource	Bauxite	3838.166560839646			mg	Ground	Europe
	Input	Natural resource	Bentonite	117.4439746391766			mg	Ground	Europe
	Input	Natural resource	Biomass	7815.358374971202			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	11.6832542083494			mg	Ground	Europe
	Input	Natural resource	Chalk	9.762512865413821E-022			mg	Ground	Europe
	Input	Natural resource	Clay	14.82782406168973			mg	Ground	Europe
	Input	Natural resource	Cr	9.133506841536686E-005			mg	Ground	Europe

	Input	Natural resource	Crude oil	791012.750310036			mg	Ground	Europe
	Input	Natural resource	Dolomite	10.16974547752791			mg	Ground	Europe
	Input	Natural resource	Fe	901.4889072720068			mg	Ground	Europe
	Input	Natural resource	Feldspar	1.464806229437003E-027			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	.7482276343079728			mg	Ground	Europe
	Input	Natural resource	Fluorite	2.05238419790896			mg	Ground	Europe
	Input	Natural resource	Granite	.1181643631703007			mg	Ground	Europe
	Input	Natural resource	Gravel	3.039377691826686			mg	Ground	Europe
	Input	Natural resource	Hard coal	639777.8225568699			mg	Ground	Europe
	Input	Natural resource	Hydro energy	0.8609120056646			MJ	Ground	Europe
	Input	Natural resource	Lignite	120016.1140039575			mg	Ground	Europe
	Input	Natural resource	Limestone	84386.26033021687			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	333.2802655078096			mg	Ground	Europe
	Input	Natural resource	Mg	0			mg	Ground	Europe
	Input	Natural resource	Natural gas	1487374.79639754			mg	Ground	Europe
	Input	Natural resource	Ni	6.576270926236523E-002			mg	Ground	Europe
	Input	Natural resource	Nitrogen	182050.0644893659			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	10.57615993992903			MJ	Ground	Europe
	Input	Natural resource	Olivine	7.728384568316456			mg	Ground	Europe
	Input	Natural resource	Oxygen	664.9637579181659			mg	Ground	Europe
	Input	Natural resource	Pb	3.320147316928043			mg	Ground	Europe
	Input	Natural resource	Peat	136.2789934002144			mg	Ground	Europe
	Input	Natural resource	Phosphate	3.277337332683021			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	1983.469532382111			mg	Ground	Europe
	Input	Natural resource	Rutile	849.3750000000001			mg	Ground	Europe
	Input	Natural resource	Sand	486.1800933640675			mg	Ground	Europe
	Input	Natural resource	Shale oils	33.07529266383717			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	72265.11869210392			mg	Ground	Europe
	Input	Natural resource	Sulphur	14454.52238445843			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	7211.490710072954			mg	Ground	Europe
	Input	Natural resource	Talc	0			mg	Ground	Europe
	Input	Natural resource	Water	702988719.802629			mg	Water	Europe
	Input	Natural resource	Wood	1229.62334317377			mg	Ground	Europe
	Input	Natural resource	Zn	24.73824271335837			mg	Ground	Europe
	Output	Emission	1,2-Dichloroethane	1.168026724418952E-006			mg	Air	Europe
	Output	Emission	1,2-Dichloroethane	2.32123830240252E-009			mg	Water	Europe
	Output	Emission	Acid as H+	52.23130184559665			mg	Water	Europe
	Output	Emission	Al	6.876921200567123			mg	Water	Europe
	Output	Emission	Aldehydes	.6044055871472318			mg	Air	Europe
	Output	Emission	As	3.837220864512839E-004			mg	Water	Europe
	Output	Emission	BOD5	3611.731229646854			mg	Water	Europe
	Output	Emission	Ca2+	11.03405522215871			mg	Water	Europe
	Output	Emission	CFCs	.250419359776042			mg	Air	Europe
	Output	Emission	Chloroorganics	.1820753234107158			mg	Air	Europe
	Output	Emission	Chloroorganics	1.827898025681445			mg	Water	Europe
	Output	Emission	Cl-	7288.36672536492			mg	Water	Europe
	Output	Emission	Cl2	.3436471824418587			mg	Water	Europe
	Output	Emission	Cl2	6.227634714730325E-002			mg	Air	Europe
	Output	Emission	CN-	2.843672413345737E-002			mg	Water	Europe
	Output	Emission	CO	3962.02377302629			mg	Air	Europe
	Output	Emission	CO2	6865046.169845278			mg	Air	Europe
	Output	Emission	CO32-	129.9539094039088			mg	Water	Europe
	Output	Emission	COD	14923.08013055204			mg	Water	Europe
	Output	Emission	CrO3	1.098951357938906E-004			mg	Water	Europe
	Output	Emission	CS2	3.200265507830805E-004			mg	Air	Europe
	Output	Emission	Cu	10.48590248187156			mg	Water	Europe
	Output	Emission	Dissolved organics	2275.057661341828			mg	Water	Europe
	Output	Emission	Dissolved solids	6924.518718015952			mg	Water	Europe
	Output	Emission	F-	8.886332716112178E-003			mg	Water	Europe
	Output	Emission	F2	2.257465665775211E-004			mg	Air	Europe
	Output	Emission	Fe	1.61299000521181			mg	Water	Europe
	Output	Emission	H2	1989.587858102603			mg	Air	Europe
	Output	Emission	H2S	1.806457680455761			mg	Air	Europe
	Output	Emission	H2SO4	1.27026518369413\9E-005			mg	Air	Europe
	Output	Emission	HCl	294.0497756647995			mg	Air	Europe

	Output	Emission	HCN	4.789992760024864E-027			mg	Air	Europe
	Output	Emission	HF	14.43988576612959			mg	Air	Europe
	Output	Emission	Hg	.204117969473993			mg	Air	Europe
	Output	Emission	Hg	7.608723279919297E-003			mg	Water	Europe
	Output	Emission	K+	61.19097208591138			mg	Water	Europe
	Output	Emission	Metals	15.75931957332073			mg	Air	Europe
	Output	Emission	Metals	196.8729745401276			mg	Water	Europe
	Output	Emission	Methane	24018.31630649041			mg	Air	Europe
	Output	Emission	Mg	.5956803717084259			mg	Water	Europe
	Output	Emission	N total	164.3721996975231			mg	Water	Europe
	Output	Emission	N2O	736.8713593034568			mg	Air	Europe
	Output	Emission	Na	4154.773239396776			mg	Water	Europe
	Output	Emission	NH3	685.6019990391103			mg	Air	Europe
	Output	Emission	NH4+	1941.75114293292			mg	Water	Europe
	Output	Emission	Ni	10.47750715615124			mg	Water	Europe
	Output	Emission	NO3-	29776.67504501806			mg	Water	Europe
	Output	Emission	NOx	26010.71697847591			mg	Air	Europe
	Output	Emission	Oil	79.04613331943376			mg	Water	Europe
	Output	Emission	Other organics	21.84736478308016			mg	Water	Europe
	Output	Emission	PAH	7.826940495941004E-028			mg	Air	Europe
	Output	Emission	Particles	8291.701623359486			mg	Air	Europe
	Output	Emission	Pb	2.12744242869416E-003			mg	Water	Europe
	Output	Emission	Pb	2.801077681688887E-004			mg	Air	Europe
	Output	Emission	Phenol	7.333860022841985			mg	Water	Europe
	Output	Emission	Phosphate	753.3921934903399			mg	Water	Europe
	Output	Emission	S2-	.706507901766078			mg	Water	Europe
	Output	Emission	SO2	25143.11245885614			mg	Air	Europe
	Output	Emission	SO42-	5570.436687039931			mg	Water	Europe
	Output	Emission	Suspended solids	1724.572746710941			mg	Water	Europe
	Output	Emission	Thiols	9.293095273423208E-002			mg	Air	Europe
	Output	Emission	Vinyl chloride	1.826753613137823E-024			mg	Water	Europe
	Output	Emission	Vinyl chloride	7.729799293235676E-007			mg	Air	Europe
	Output	Emission	VOC	46.41973021124039			mg	Water	Europe
	Output	Emission	VOC	3336.43			mg	Air	Europe
	Output	Emission	Zn	9.069596488977075E-003			mg	Water	Europe
	Output	Product	PA 66	1			kg	Technosphere	Europe
	Output	Residue	Construction	28.68844208999855			mg	Ground	Europe
	Output	Residue	Industrial	7960.410249271234			mg	Ground	Europe
	Output	Residue	Inert chemical	4085.743734857435			mg	Ground	Europe
	Output	Residue	Metals	63.36684741789236			mg	Ground	Europe
	Output	Residue	Mineral	149553.1758546264			mg	Ground	Europe
	Output	Residue	Paper	4.977200931347489E-021			mg	Ground	Europe
	Output	Residue	Plastics	253.3591669870358			mg	Ground	Europe
	Output	Residue	Recovered energy	4.735132258219832			MJ	Technosphere	Europe
	Output	Residue	Regulated chemical	2294.068014618854			mg	Ground	Europe
	Output	Residue	Slags & ashes	30685.58750946772			mg	Ground	Europe
	Output	Residue	To incinerator	317.9363874456623			mg	Technosphere	Europe
	Output	Residue	To recycling	91.25974212889669			mg	Technosphere	Europe
	Output	Residue	Unspecified	21.7096794323451			mg	Ground	Europe
	Output	Residue	Wood waste	12.29224647736394			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for nylon 66. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME´s web site http://lca.apme.org. -- Data documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development. Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 27 November 2001 ---
Intended User	1. APME member companies 2. L

General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	European average data. Results are based on data supplied by 3 production plants in 2 countries: France and Germany. Their total production was 28 000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for nylon 66 production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of nylon 66 in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity.

	According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

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SPINE LCI dataset: Production of orthoxylene. ESA-DBP

Administrative	
Finished	Y
Date Completed	1997
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Production of orthoxylene. ESA-DBP
Functional Unit	1 kg of orthoxylene

Functional Unit Explanation	Unknown
Process Type	Gate to gate
Site	Unknown
Sector	Chemicals and chemical products
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''Orthoxylene is made from naphtha. (...) This activity is described as a two step process. The naphtha has been replaced with refinery products (...).'' This process is included in the system described in: Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Manufacturing of CD-R (Compact Disc-Recordable). ESA-DBP - Manufacturing of CD-ROM (Compact Disc - Read Only Memory). ESA-DBP - Dioctyl phthalate (DOP) production. ESA-DBP - Cultivation and felling of trees for papermaking. ESA-DBP - Cardboard production (MDF based). ESA-DBP - Production of copypaper. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) and emissions to air.
Time Boundary	1995
Geographical Boundary	Sweden
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''In Jönsson (1995), this activity is described as a two step process. Here, the two steps are aggregated.''
Literature Reference	Jönsson, Å. Life Cycle Assessment of Flooring Materials. Göteborg: Chalmers University of Technology. Technical Environmental Planning, 1995:3
Notes	Excerpt from the report, see 'Publication': ''The naphtha has been replaced with refinery products as described above.''

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	1.20E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Gas	2.16E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Refinery product	1.00E+00			kg	Technosphere	Sweden
	Output	Emission	CO	8.00E-02			g	Air	Sweden
	Output	Emission	CO2	2.45E+00			g	Air	Sweden
	Output	Emission	SOx	1.50E+00			g	Air	Sweden
	Output	Product	Orthoxylene	1.00E+00			kg	Technosphere	Sweden

About Inventory

Publication	Beckman T. (1997). Gutenberg versus IT. A Life Cycle Assessment of printed and CD-stored information. Technical Environmental Planning, Report 1997:3, Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner

General Purpose	The study was done for the purpose of master thesis.
Detailed Purpose	Excerpt from the report: ''The goal of this study is to undertake an life cycle assessment (LCA) of different alternatives for Ericsson to provide their customers with reference libraries to the Ericsson Consolo MD110 telephone exchange system. The different documentation alternatives investigated in this study are: plastic ring binders, paperbacks, CD-R records and CD-ROM records.''
Commissioner	Ericsson, Stockholm, Sweden - .
Practitioner	Torsten Beckman - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	NB: The inventory results for the whole life cycle (from cradle to grave) of binders, paperbacks, CD-Rs and CD-ROMs can be found in the reference report.

SPINE LCI dataset: Production of paint and anti corrosion agents

Administrative

Finished	Y
Date Completed	1996-03-01
Copyright	
Availability	Public

Technical System

Name	Production of paint and anti corrosion agents
Functional Unit	m3
Functional Unit Explanation	1 m3 produced paint and anti corrosion agents The actual production consists of 45,2% Paint (1. class) 34,4% Oil (2. class) 19,3% Mass (3. class) 1,16% Other products
Process Type	Gate to gate
Site	Geveko Industri AB Box 13007 40251 Göteborg
Sector	Materials and components
Owner	Geveko Industri AB Box 13007 40251 Göteborg
Technical system description	The company produces paint and anti corrosion agents through mixing of solid and liquid raw materials in mixers, dissolvers and reactors. Allowed production 20 000 m3 paint and anti corrosion agents.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified
Represents	See 'Function'
Method	Study the Environmental report The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1995, which was 2590 m3 paint and similar products.
Literature Reference	Jönsson, Å. Life Cycle Assessment of Flooring Materials. Göteborg: Chalmers University of Technology. Technical Environmental Planning, 1995:3
Notes	Excerpt from the report, see 'Publication': ''The naphtha has been replaced with refinery products as described above.''

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1995 Data type: Unspecified Notes: Consist of Siccativ, Methyl ethyl ketoxine and thickeners (organic, modified clay). The substances are bound in the finished product.	Input	Refined resource	Additives	20.92664093			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: The solvents are used in paint, thinners and anti corrosion agents. The solvents evaporate through the processing air to the cleaning plant. Water from washing-up and spillage is handled as hazardous waste. The main part of the solvents are bound in the products.	Input	Refined resource	Aliphatic solvents	132.2393822			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: 25 % ammonia, the rest water. The substanse is bound in the product	Input	Refined resource	Ammonia	0.003861004			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: The solvents are used in paint, thinners and anti corrosion agents. The solvents evaporate through the processing air to the cleaning plant. Water from washing-up and spillage is handled as hazardous waste. The main part of the solvents are bound in the products.	Input	Refined resource	Aromatic solvents	79.53667954			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Consists of the following substances: Fatty acid alkyd and Hydrocarbon harts, both used in paint Bitumen, wax, petroleum sulphonate and highly refined mineral oil, all used in anti corrosion agents Polyuretan prepolymer used in heat hardening mass All substances are bound in the finished products	Input	Refined resource	Binding agents	38.61003861			kg	Technosphere	

Date concieved: 1995 Data type: Unspecified Notes: Consist of Calcium carbonate, talk, fibreglass, natural barium sulphate, hydrogenated aluminiumsilicate and Pigmatit feldspar. The substances are bound in the products. Not hazardous to the environment	Input	Refined resource	Fillers	266.7953668			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in paint and anti corrosion agents. The pigments are bound in the products. Not hazardous to the environment	Input	Refined resource	Inorganic pigments	37.45173745			kg	Technosphere	
	Input	Refined resource	Natural gas	52.50965251			m3	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Consists of Laromin, which is used as hardener, and Berolamin, which is paint. The substance is bound in the product	Input	Refined resource	Organic amines	9.536679537			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in paint and anti corrosion agents. The pigments are bound in the products. Not hazardous to the environment	Input	Refined resource	Organic pigments	0.965250965			kg	Technosphere	
Notes: Softyening agent, used in paint. The substance is bound in the product.	Input	Refined resource	Poly glucol	0.347490347			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: The solvents are used in paint, thinners and anti corrosion agents. The solvents evaporate through the processing air to the cleaning plant. Water from washing-up and spillage is handled as hazardous waste. The main part of the solvents are bound in the products.	Input	Refined resource	Solvents	31.27413127			kg	Technosphere	
	Output	Emission	Solvents	0.001930502			tonne	Air	
Date concieved: 1995 Data type: Unspecified Notes: Consists of Wood, Paper and Plastic	Output	Residue	Combustible waste	0.098841699			m3	Technosphere	
	Output	Residue	Plates	0.040926641			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Disposed at Reci Industri AB.	Output	Residue	Waste solvents	0.003474903			tonne	Technosphere	

About Inventory

Publication	The environmental report from Geveko Industri AB for 1995, The Board of County in Göteborg and Bohus -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden.
Practitioner	Tranberg Ulf - Geveko Industri AB Box 13007 40251 Göteborg.
Reviewer	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden

Applicability	The function of the technical system is not sufficently described. Contact the company to get the necessary details. No margin of error is found in the report, and one can assume that a lot of values have been rounded. The values often end with zeroes and occasionally are indicated to be an approximation.
About Data	
Notes	

SPINE LCI dataset: Production of paint, thinner and enamel mainly for surface treatment of steel

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Production of paint, thinner and enamel mainly for surface treatment of steel
Functional Unit	m3
Functional Unit Explanation	1 m3 produced paint, enamel and thinner. The percentage of the different products is unspecified.
Process Type	Gate to gate
Site	International Färg AB Box 44 424 22 Angered Sweden
Sector	Materials and components
Owner	International Färg AB Box 44 424 22 Angered Sweden
Technical system description	The main ingredients in the paint production are pigments, binders and solvents, which are put together through powerful stirring. In some cases further grinding is necessary. This is done in sand mills. After the preparation, adjustment and control the product is filtrated and pored in to the packing in question. The production is secluded.

System Boundaries	
Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1996

Data Type	Unspecified
Represents	See 'Function'
Method	Studying the Environmental report. The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1996, which was 12621 m3 paint, enamel and thinner.
Literature Reference	The Environmental Report from International Färg AB for 1996, The Environmental Administration in the municipality of Göteborg.
Notes	The data type unspecified implies that one does not know the origin of the data. The method is specified for the emissions of CO2 and VOC.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1996 Data type: Unspecified Method: The method is not described Notes: Blysicktiv consists of 33% Pb.	Input	Refined resource	Blysicktiv	0.475398			kg	Technosphere	
	Input	Refined resource	Chlorine parrafin	0.611679			kg	Technosphere	
	Input	Refined resource	Chromium oxide	0.602171			kg	Technosphere	
	Input	Refined resource	Cr3O	0.465494			kg	Technosphere	
	Input	Refined resource	Lead cromate	0.491245			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: The oil is fuel (heating) oil, with less than 0,1% S.	Input	Refined resource	Oil	0.0282783			m3	Technosphere	
	Input	Refined resource	Phtalate	0.305047			kg	Technosphere	
	Input	Refined resource	Stontiumkromat	4.04088			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: The method is not described Notes: The tin is used as an organic catalyst.	Input	Refined resource	Tin	0.023761			kg	Technosphere	
	Input	Refined resource	Zinc chromate	0.26345			kg	Technosphere	
	Input	Refined resource	Zinc oxide	1.57674			kg	Technosphere	
	Input	Refined resource	Zinc phosphate	10.7757			kg	Technosphere	
	Input	Refined resource	Zn	86.8394			kg	Technosphere	
Date concieved: 1996 Data type: Random sample Method: The taking of specimens is done by ÅF-IPK AB. The instrument used is an IR-Instrument of type Binos. The range of measurement of the IR-instrument is for CO2 0-20%. The instrument is calibrated with a known sample, and the margin of error is 2%.	Output	Emission	CO2	0.0904841			kg	Air	
	Output	Emission	NOx	0.0961097			kg	Air	
	Output	Emission	SO2	0.0452421			kg	Air	
Date concieved: 1996 Data type: Modeled data Method: The taking and analysing of specimens are done by the company ÅF-IPK AB, Kvarnbergsgatan 2, Box 1551, 401 51 Göteborg, Sweden, Phone number +46 (0)31 7431000. The amount of total hydrocarbon is measured with a devise which detects flam ionization. The ionization causes a signal, in the detector. The signal is approximately proportiunal to the	Output	Emission	VOC	2.21852			kg	Air	

amount of carbon, which through conbustion becomes carbon dioxide. This method is commonly used, and found to be relyable. It is also one of the few that allows continuous determination of the variation of the carbon content. Different carbon combines give different signal levels, because of the carbon's bond. This gives an error to the result. The instrument gives readings in parts per million. To get the reading in mg/m3 one multiplies with the mole mass of the substance in question and devides with the number of carbon atoms in 1 m3 air. The instrument used is Bernard Atomic 3005, and it has been calibrated with a known sample. The taking of specimens were done during W23 and W50. The level of production were not the same on two occations. Also the flow of gas and its temperature were measured during these weeks, so that the concentration could be converted to an amount. The flow of gas is measured by a Pitot tube and a micromanometer. The temperature is measured by thermal converter. The results: W24 2,2 kg emitted VOC per year and per m3 produced paint, when the level of production was 14 500 m3/year. W50 1,5 kg emitted VOC per year and per m3 produced paint, when the level of production was 11 300m3/year. To get the final result of the emitted VOC per year the results from the takning of specimens have to be converted to the actuall year limit of production . This is done by a calculation, which assumes a proportional connection between the limit of production and the emission. The company, hired to do the taking and analysing of the specimens, uses the highest allowed limit (18 000 m3/year) and not the actuall limit of production (12 621 m3/year), which is lower. the result then is 2,6 kg. The result given from this calculations is said to have approximatly 30% margin of error. In the environmental report International Färg AB uses the figure you get, when assuming you have the same limit of production the whole year as it was during W24. The value for the emitted VOC for this week was considerably higher than during the second measuring period (W50) and also noticeably higher than the actual level of production. Literature: The Environmental report from Internationel AB from 1996, The Environmental Administration in the municipality of Göteborg.										
	Output	Product	Paint/Enamel /Thinner	1			m3	Technosphere		
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: The waste paper is recycled	Output	Residue	Corrugated cardboard	1.82236			kg	Technosphere		
Date concieved: 1996 Data type: Unspecified Notes: 28,0% of the rest products are combustioned and the rest is dumped.	Output	Residue	Other rest products	18.0651			kg	Technosphere		

Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: Is recycled.	Output	Residue	Scrap-steel	29.1578			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: Also contains waste from enamels. Hazardous for the environment. The waste is transported by Närkefrakt.	Output	Residue	Waste paint	31.3221096			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Hazardous for the environment. The waste is transported by Närkefrakt.	Output	Residue	Waste solvents	1.7180904			kg	Technosphere	

About Inventory	
Publication	The Environmental report for International Färg AB from 1997, The Environmental Administration in the municipality of Göteborg -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Eliasson, Hans - International Färg AB Box 44 424 22 Angered Sweden .
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	
About Data	
Notes	

SPINE LCI dataset: Production of PE-film

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	

Technical System	
Name	Production of PE-film
Functional Unit	1 kg
Functional Unit Explanation	1 kg film.
Process Type	Gate to gate

Site	Rosenlew emballage AB
Sector	Consumer goods
Owner	Rosenlew emballage AB
Technical system description	Production of film, used for packing. The film is produced of low-pressure polyethylene. An electric extruder is used.

System Boundaries

Nature Boundary	Only emissions to air are accounted for in the system.
Time Boundary	
Geographical Boundary	
Other Boundaries	The energy consumption and the film produced are accounted for in the system.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991
Data Type	Unspecified
Represents	See 'Function'
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992, where the data is based on both information from Lars Karlsson, Rosenlewen Emballage AB and Chalmers Industripark, Resurs- och avfallssnäla förpackningar, Electrolux-PADD'', 1990, Göteborg.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992
Notes	The data type unspecified implies that one does not know the origin of the data. The method is specified for the emissions of CO2 and VOC.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: The figure is based on information from Chalmers Industripark, Resurs- och avfallssnäla förpackningar, Electrolux-PADD'', 1990, Göteborg	Input	Refined resource	Electricity	3.10			MJ	Technosphere	
Method: The figure is based on information from Lars Karlsson, Rosenlewen Emballage AB. Notes: Antioxidant	Output	Emission	BHT	0.30			g	Air	
	Output	Product	Film	1			kg	Technosphere	
Notes: The waste film is recycled.	Output	Residue	Film	0.136			kg	Technosphere	

About Inventory

Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about packaging and the environment.
Detailed Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.

Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. There is no raw material going in to the system, which most lightly is the case. The raw material is low-pressure polyethylene. The emissions caused by the production of the electricity used in the system are not accounted for.
About Data	
Notes	

SPINE LCI dataset: Production of pentane (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of pentane (APME)
Functional Unit	1 kg pentane
Functional Unit Explanation	Pentane has the chemical structure CH3-CH2-CH2-CH2-CH3. Pentane is used as blowing agent for foams.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. All flows have been followed to the cradle. However, only the main production process is been described here. Pentane occurs naturally as part of the light fraction of crude oil and to a lesser extent in natural gas. It is readily extracted and purified during refinery operations. Smaller quantities of pentane occur as by-products in petrochemical processing and where there are sufficient quantities it is extracted for sale. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1990-1996. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 3 pentane producers in France, Netherlands and Germany. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 3 pentane production plants in 3 countries: France, Germany and Netherlands. Their total production is not known: data was supplied in normalised format.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1990-1996
Data Type	Derived, mixed
Represents	See 'Function'
Method	European average data. Results are based on data supplied by 3 pentane production plants in 3 countries: France, Germany and Netherlands. Their total production is not known: data was supplied in normalised format. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Air	95703.49295			mg	Air	Europe
	Input	Natural resource	Barytes	0.236867104			mg	Ground	Europe
	Input	Natural resource	Bauxite	531.7516913			mg	Ground	Europe
	Input	Natural resource	Bentonite	34.47813122			mg	Ground	Europe
	Input	Natural resource	Biomass	1150.713671			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	3.438804096			mg	Ground	Europe
	Input	Natural resource	Chalk	3.70E-21			mg	Ground	Europe
	Input	Natural resource	Chromium in ore	4.70E-04			mg	Ground	Europe
	Input	Natural resource	Clay	22.88944864			mg	Ground	Europe
	Input	Natural resource	Crude oil	1160485.251			mg	Ground	Europe
	Input	Natural resource	Dolomite	1.483980652			mg	Ground	Europe
	Input	Natural resource	Feldspar	6.43E-27			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	0.110246055			mg	Ground	Europe
	Input	Natural resource	Fluorite	0.236505745			mg	Ground	Europe
	Input	Natural resource	Granite	5.98E-03			mg	Ground	Europe
	Input	Natural resource	Gravel	0.44783083			mg	Ground	Europe
	Input	Natural resource	Hard coal	22955.67217			mg	Ground	Europe
	Input	Natural resource	Hydro energy	0.945061026			MJ	Ground	Europe
	Input	Natural resource	Iron in ore	234.5353371			mg	Ground	Europe
	Input	Natural resource	Lead in ore	7.75E-02			mg	Ground	Europe
	Input	Natural resource	Lignite	994.7550581			mg	Ground	Europe
	Input	Natural resource	Limestone	622.8557892			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	52.91672074			mg	Ground	Europe
	Input	Natural resource	Natural gas	390186.2146			mg	Ground	Europe
	Input	Natural resource	Nickel in ore	1.17E-04			mg	Ground	Europe
	Input	Natural resource	Nitrogen	12783.03857			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	6.78E-02			MJ	Ground	Europe

	Input	Natural resource	Olivine	1.138722866			mg	Ground	Europe
	Input	Natural resource	Oxygen	21.93337147			mg	Ground	Europe
	Input	Natural resource	Peat	25.1423803			mg	Ground	Europe
	Input	Natural resource	Phosphate	0.16594985			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	13.76532597			mg	Ground	Europe
	Input	Natural resource	Rutile	5.32E-21			mg	Ground	Europe
	Input	Natural resource	Sand	64.03746212			mg	Ground	Europe
	Input	Natural resource	Shale oils	9.735254395			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	973.0195924			mg	Ground	Europe
	Input	Natural resource	Sulphur	19.34852846			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	5.511451941			mg	Ground	Europe
	Input	Natural resource	Water, cooling	55894477.2			mg	Water	Europe
	Input	Natural resource	Water, process	1526323			mg	Water	Europe
	Input	Natural resource	Wood	3.500995138			mg	Ground	Europe
	Input	Natural resource	Zinc in ore	2.91E-03			mg	Ground	Europe
	Output	Co-product	Recovered energy	0.722033484			MJ	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	3.20E-04			mg	Air	Europe
	Output	Emission	Acid as H+	44.90443745			mg	Water	Europe
	Output	Emission	Al	8.83E-03			mg	Water	Europe
	Output	Emission	Aldehydes	1.55E-03			mg	Air	Europe
	Output	Emission	As	8.09E-07			mg	Water	Europe
	Output	Emission	BOD5	23.81506679			mg	Water	Europe
	Output	Emission	Ca2+	2.066422651			mg	Water	Europe
	Output	Emission	CFCs	0.91274348			mg	Air	Europe
	Output	Emission	Chloroorganics	4.38E-02			mg	Air	Europe
	Output	Emission	Chloroorganics	4.86E-03			mg	Water	Europe
	Output	Emission	Cl-	259.4904088			mg	Water	Europe
	Output	Emission	Cl2	1.13E-03			mg	Water	Europe
	Output	Emission	Cl2	6.03E-04			mg	Air	Europe
	Output	Emission	CN-	6.91E-02			mg	Water	Europe
	Output	Emission	CO	462.314564			mg	Air	Europe
	Output	Emission	CO2	1166595.627			mg	Air	Europe
	Output	Emission	CO32-	28.58247713			mg	Water	Europe
	Output	Emission	COD	121.2323757			mg	Water	Europe
	Output	Emission	CrO3	5.66E-04			mg	Water	Europe
	Output	Emission	CS2	1.16E-07			mg	Air	Europe
	Output	Emission	Cu	3.14E-02			mg	Water	Europe
	Output	Emission	Dissolved organics	41.47198126			mg	Water	Europe
	Output	Emission	Dissolved solids	206.723684			mg	Water	Europe
	Output	Emission	F-	7.70E-04			mg	Water	Europe
	Output	Emission	F2	1.71E-05			mg	Air	Europe
	Output	Emission	Fe	8.43E-02			mg	Water	Europe
	Output	Emission	H2	67.51032474			mg	Air	Europe
	Output	Emission	H2S	4.80E-03			mg	Air	Europe
	Output	Emission	H2SO4	2.45E-04			mg	Air	Europe
	Output	Emission	HCl	8.817654289			mg	Air	Europe
	Output	Emission	HCN	1.82E-26			mg	Air	Europe
	Output	Emission	HF	0.372733156			mg	Air	Europe
	Output	Emission	Hg	5.52E-03			mg	Air	Europe
	Output	Emission	Hg	9.08E-05			mg	Water	Europe
	Output	Emission	K+	0.402392719			mg	Water	Europe
	Output	Emission	Metals	2.777245194			mg	Air	Europe
	Output	Emission	Metals	96.43947161			mg	Water	Europe
	Output	Emission	Methane	4569.547495			mg	Air	Europe
	Output	Emission	Mg	2.51E-02			mg	Water	Europe
	Output	Emission	N total	1.908828506			mg	Water	Europe
	Output	Emission	N2O	0.26062944			mg	Air	Europe
	Output	Emission	Na	189.4548107			mg	Water	Europe
	Output	Emission	NH3	1.14E-03			mg	Air	Europe
	Output	Emission	NH4+	4.63956639			mg	Water	Europe
	Output	Emission	Ni	3.13E-02			mg	Water	Europe
	Output	Emission	NO3-	0.361415042			mg	Water	Europe
	Output	Emission	NOx	6519.302087			mg	Air	Europe
	Output	Emission	Oil	84.08342006			mg	Water	Europe
	Output	Emission	Other organics	2.362857185			mg	Water	Europe

	Output	Emission	PAH	43.2666234			mg	Air	Europe
	Output	Emission	Particles	756.9238341			mg	Air	Europe
	Output	Emission	Pb	4.02E-05			mg	Air	Europe
	Output	Emission	Pb	4.68E-03			mg	Water	Europe
	Output	Emission	Phenol	1.51415667			mg	Water	Europe
	Output	Emission	PO43-	0.268579033			mg	Water	Europe
	Output	Emission	S2-	1.095809434			mg	Water	Europe
	Output	Emission	SO2	5084.539578			mg	Air	Europe
	Output	Emission	SO42-	35.417287			mg	Water	Europe
	Output	Emission	Suspended solids	347.7811189			mg	Water	Europe
	Output	Emission	Thiols	9.37E-05			mg	Air	Europe
	Output	Emission	Vinyl chloride	3.20E-04			mg	Air	Europe
	Output	Emission	Vinyl chloride	6.93E-24			mg	Water	Europe
	Output	Emission	VOC	1.094711723			mg	Air	Europe
	Output	Emission	VOC	1410.557934			mg	Air	Europe
	Output	Emission	VOC	28.89181727			mg	Water	Europe
	Output	Emission	VOC, aromatic	5.952535734			mg	Air	Europe
	Output	Emission	Zn	1.12E-04			mg	Water	Europe
	Output	Product	Pentane	1			kg	Technosphere	Europe
	Output	Residue	Construction	44.73949395			mg	Ground	Europe
	Output	Residue	Industrial	1124.83248			mg	Ground	Europe
	Output	Residue	Inert chemical	228.0398783			mg	Ground	Europe
	Output	Residue	Metals	10.41235283			mg	Ground	Europe
	Output	Residue	Mineral	6183.305406			mg	Ground	Europe
	Output	Residue	Plastics	13.36471026			mg	Ground	Europe
	Output	Residue	Regulated chemical	936.7678974			mg	Ground	Europe
	Output	Residue	Slags & ashes	1223.87647			mg	Ground	Europe
	Output	Residue	To incinerator	39.7915601			mg	Technosphere	Europe
	Output	Residue	To recycling	3.42E-02			mg	Technosphere	Europe
	Output	Residue	Unspecified	44.12363403			mg	Ground	Europe
	Output	Residue	Wood waste	3.49E-02			mg	Ground	Europe

About Inventory

Publication

''Eco-profiles of the European plastics industry'', report for pentane.
''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999.
Reports are available at APME's web site http://lca.apme.org.

Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development

Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology

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Intended User

1. APME member companies
2. L

General Purpose

The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.

Detailed Purpose

Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses.

1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes

2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products.

Objectives and areas of application for the Eco-profiles:
- Plastics waste management studies
- Internal company benchmarking
- Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems.
- Ensuring that the data are neutral.

The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies

	has improved since then.
Commissioner	
Practitioner	Boustead, Ian - .
Reviewer	Not available -
Applicability	European average data. Results are based on data supplied by 3 pentane production plants in 3 countries: France, Netherlands and Germany. Their total production is not known: data was supplied in normalised format. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for pentane production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of pentane in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand

	Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

SPINE LCI dataset: Production of petrochemical Alcohol Ethoxylates (AE) with 3 moles of ethylene oxide (EO)

Administrative	
Finished	Y
Date Completed	1995-01-01
Copyright	Carl Hanser Verlag
Availability	Public

Technical System	
Name	Production of petrochemical Alcohol Ethoxylates (AE) with 3 moles of ethylene oxide (EO)
Functional Unit	1000 kg
Functional Unit Explanation	All emissions, use of resources and energy consumption is based on 1000 kg of AE (3 EO).
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	BRIEF DESCRIPTION: The following steps are included in the production of fatty alcohol ethoxylate with 3 EO: Crude oil production: The study includes drilling, pumping and separation of crude oilk from brine water and tank storage. Crude oil refining: The refining includes desalting, hydrotreating and distillation (fractionation/extraction of crude oil into paraffins, olefins, benzene and ethylene). Natural gas production: The study includes drilling, pumping and tank storage. Natural gas processing: No details were given. Ethylene production: Ethylene is produced from natural gas and oil. n-Paraffin production: n-paraffins are produced from oil. Olefins production: Olefins are produced from ethylene and n-paraffins. Alcohol production: The alcohols are produced from olefins and ethylene. The production includes the production of methyl esters requiring methanol made from natural gas. Oxygen production: Oxygen is used in the process of making ethylene oxide. No details were given on oxygen production. Ethylene oxide production: Ethylene oxide is derived from ethylene and oxygen through an exothermic process. Alcohol ethoxylation (with 3 moles of ethylene oxide): Alcohol ethoxylates are produced by the reaction of detergent range alcohols with ethylene oxide. The addition of EO to detergent range alcohols leads to a distribution of homologue polyethylene glycoether groups. Information concerning all the subsystems described above: Transports are included in the system. The fuels for the transports and the fuels for the processes are traced back to the extraction of petrochemical raw materials and/or extraction of bio fuels. The electricity data are based on the electricity profile for each country and the petrochemical and biomass raw materials for electricity production are traced back to the extraction process (same process as for fuel raw materials).

System Boundaries	
Nature Boundary	All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The process data used in the study pertain mainly to 1992, being yearly averages where possible. It is recognised that operating processes and conditions are constantly evolving. Indeed, one purpose of the study is to facilitate and encourage the use of systems with improved environmental profiles. Because such changes will inevitably occur, the data obtained in this study provide a reference against which they can be measured.
Geographical Boundary	This study examined the surfactant production in Europe, notably manufacturing processes conducted in Belgium, France, Germany, Italy, the Netherlands, Spain and the United Kingdom.
Other Boundaries	The detergent formulation, use and final disposal of the surfactants were not covered. The environmental effects associated with the manufacture of capital equipment and with energy and fuel requirements for plant and building conditioning (heat, air etc.) were not included, neither were those associated with personnel requirements. For electricity based on nuclear power and wind power, no emissions and resource exploits have been accounted for.
Allocations	Raw materials, energy and environmental emissions are allocated among co-products on an output weight basis, i.e. on the basis of mass. Co-products in this LCI include those materials that are currently recycled, reused or marketed in some beneficial way.
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study)

Flow Data	
General Activity QMetaData	
Date Conceived	1992
Data Type	
Represents	
Method	LC-inventory. Data come from tables 1-4 on pages 172-173 in lit.ref.
Literature Reference	Tenside Surfactants Detergents; 32. Jahrgang 2/1995; Carl Hanser Verlag; Munchen
Notes	The raw material data are given in ''kg'' and the energy data are given in ''MJ''. However, it is important to remember that the raw materials themselves have an energy content.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Energy resource. The thermal value for natural gas is 45 MJ/kg.	Input	Natural resource	Coal	4590			MJ	Ground	
Notes: Energy resource. The thermal value for crude oil is 42 MJ/kg.	Input	Natural resource	Crude oil	4662			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Crude oil	621			kg	Ground	
Notes: Energy resource. the thermal value for natural gas is 45 MJ/kg.	Input	Natural resource	Natural gas	15750			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Natural gas	458			kg	Ground	
Notes: Raw material.	Input	Natural resource	Nitrogen	18			kg	Air	
Notes: Raw material.	Input	Natural resource	Oxygen	351			kg	Air	
Represents: Electricity produced by hydro power. Notes: Source of energy.	Input	Refined resource	Hydro power	330			MJ	Technosphere	
Represents: Electricity produced by nuclear power. Notes: Source of energy.	Input	Refined resource	Nuclear	2800			MJ	Technosphere	
	Output	Emission	Acid	0.073			kg	Water	
	Output	Emission	Al	15			mg	Water	
	Output	Emission	Aldehydes	0.044			kg	Air	
	Output	Emission	BOD	1.34			kg	Water	
	Output	Emission	CH4	0.012			kg	Air	
	Output	Emission	Chloride	0.21			kg	Water	
	Output	Emission	Chlorine	0.0055			kg	Air	
	Output	Emission	CO	1.41			kg	Air	

Notes: Fossil emissions of CO2. Non-fossil emissions from the process do not exist.	Output	Emission	CO2	2233			kg	Air	
	Output	Emission	COD	2.7			kg	Water	
	Output	Emission	Cr	0.0055			kg	Water	
	Output	Emission	Dissolved solids	1.94			kg	Water	
	Output	Emission	Fe	0.022			kg	Water	
	Output	Emission	Fluorides	0.0083			kg	Water	
	Output	Emission	Fluorine	0.0055			kg	Air	
	Output	Emission	HC	0.011			kg	Water	
	Output	Emission	HC	36.2			kg	Air	
	Output	Emission	HCl	0.11			kg	Air	
	Output	Emission	HF	0.0088			kg	Air	
	Output	Emission	Metal ion	0.013			kg	Water	
	Output	Emission	Metals	0.0055			kg	Air	
	Output	Emission	NH3	0.005			kg	Water	
	Output	Emission	NH3	0.018			kg	Air	
	Output	Emission	Ni	50			mg	Water	
	Output	Emission	NOx	17.9			kg	Air	
	Output	Emission	Oil	0.018			kg	Water	
	Output	Emission	Other chemicals	0.13			kg	Water	
	Output	Emission	Other organics	0.43			kg	Air	
	Output	Emission	Particles	4.31			kg	Air	
	Output	Emission	Pb	5.4			mg	Air	
	Output	Emission	Phenol	0.0058			kg	Water	
	Output	Emission	Phosphates	0.003			kg	Water	
	Output	Emission	Solid waste	67			kg	Ground	
	Output	Emission	SOx	13.2			kg	Air	
	Output	Emission	Sulphates	0.46			kg	Water	
	Output	Emission	Sulphides	0.03			kg	Water	
	Output	Emission	Susp solids	0.17			kg	Water	
	Output	Emission	Zn	0.0019			kg	Water	
	Output	Product	Alcohol ethoxylate (3 EO)	1000			kg	Technosphere	

About Inventory	
Publication	Tenside Surfactants Detergents; 32. Jahrgang 2/1995; Carl Hanser Verlag; Munchen -- Data documented by: Malin Ericson, Akzo Nobel Surface Chemistry Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	All manufacturers and users of
General Purpose	-To produce an authoritative and comprehensive Life Cycle Inventory for major surfactant production in Europe through a common approach in order to facilitate objectivity in surfactant assessments on environmental grounds. -To secure the best possible validation of data and broad acceptance of the methodology and conclusions by industry, regulatory authorities, and academia, through assessment of the study by an appropriate expert review panel.
Detailed Purpose	-To establish an industry-wide inventory of the energy, emissions and resource exploits associated with the production of major surfactants in Western Europe under the conditions prevailing in 1992. -To bring together environmental data on the use of the main raw material sources - crude oil, natural gas, mineral, oleochemical, agricultural feedstock - for the processing pathways to the derived major surfactants. -To provide benchmarks for the processing steps of surfactant production against which individual producers can assess their own processes and identify opportunities for improvement. -To publish the results of the study and its conclusions in the open literature for access and reference by interested bodies.
Commissioner	- European LCI Surfactant Study Group (CEFIC/ECOSOL).
Practitioner	- Franklin Associates, Ltd. 4121 W. 83rd St., Suite 108 Prairie Village, KS 66208, USA.
Reviewer	Klöppfer, Prof. Dr. W. - C.A.U. Consultants Frankfurt, Germany

Applicability	It is generally not possible to replace one surfactant type by another without changing other components of a preparation, or altering performance characteristics. Therefore, it is not in general meaningful to compare surfactants on a weight basis. Alcohols ethoxylates are the largest group of nonionic detergent range alcohols.The particular alcohol ethoxylate covered in this study is mainly used in detergents. Alcohol ethoxylates are less sensitive to water hardness compared to anionic surfactants.
About Data	13 industrial companies participated in the project, including major surfactant manufacturers, raw material and intermediate suppliers, as well as surfactant users in Europe, some of whom are both manufacturers and users. Participating companies are BASF, Colgate-Palmolive, Condea, Enichem Augusta, Henkel, Hoechst, Hüls, ICI, Petresa, Procter & Gamble, Shell, Unilever and Wibarco. Process data were obtained directly from each company performing the process. These data were often proprietary. Therefore, technical process data from private corporations were collected from a minimum of three producers for each intermediate and surfactant type. The information is presented in the form of industry averages in order to preserve confidentiality. Fuel-related data for European countries were based on various governmental statistics and industry contacts (aggregated and provided by Dr. I. Bousted, The Open University, UK).
Notes	Data for other surfactants such as Alcohol sulphates (AS), Alcohol ethoxy sulphates (AES), soap, Secondary alkane sulphonates (SAS), Linear alkylbenzene sulphonates (LAS) and Alkyl polyglucosides (APG) were given in the same study.

SPINE LCI dataset: Production of petrochemical Alcohol Ethoxylates (AE) with 7 moles of ethylene oxide (EO)

Administrative	
Finished	Y
Date Completed	1995-01-01
Copyright	Carl Hanser Verlag, Munchen
Availability	Public

Technical System	
Name	Production of petrochemical Alcohol Ethoxylates (AE) with 7 moles of ethylene oxide (EO)
Functional Unit	1000 kg
Functional Unit Explanation	All emissions, use of resources and energy consumption is based on 1000 kg of AE (7EO).
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	BRIEF DESCRIPTION: The following steps are included in the production of fatty alcohol ethoxylate with 7 EO : Crude oil production: The study includes drilling, pumping and separation of crude oilk from brine water and tank storage. Crude oil refining: The refining includes desalting, hydrotreating and distillation (fractionation/extraction of crude oil into paraffins, olefins, benzene and ethylene). Natural gas production: The study includes drilling, pumping and tank storage. Natural gas processing: No details were given. Ethylene production: Ethylene is produced from oil and gas.

	n-Paraffin production: n-paraffin is produced from oil. Olefins production: Olefins are produced from ethylene and n-paraffins. Alcohol production: The alcohols are produced from olefins and ethylene. The production includes the production of methyl esters requiring methanol made from natural gas. Oxygen production: Oxygen is needed in the production of ethylene oxide. No details were given on oxygen production. Ethylene oxide production: Ethylene oxide is derived from ethylene and oxygen through an exothermic process. Alcohol ethoxylation (with 7 moles of ethylene oxide): Alcohol ethoxylates are produced by the reaction of detergent range alcohols with ethylene oxide. The addition of EO to detergent range alcohols leads to a distribution of homologue polyethylene glycoether groups. Information concerning all the subsystems described above: Transports are included in the system. The fuels for the transports and the fuels for the processes are traced back to the extraction of petrochemical raw materials and/or the extraction of bio fuels. The electricity data are based on the electricity profile for each country and the petrochemical and biomass raw materials for electricity production are traced back to the extraction process (same process as for fuel raw materials).

System Boundaries

Nature Boundary	All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The process data used in the study pertain mainly to 1992, being yearly averages where possible. It is recognised that operating processes and conditions are constantly evolving. Indeed, one purpose of the study is to facilitate and encourage the use of systems with improved environmental profiles. Because such changes will inevitably occur, the data obtained in this study provide a reference against which they can be measured.
Geographical Boundary	This study examined the surfactant production in Europe, notably manufacturing processes conducted in Belgium, France, Germany, Italy, the Netherlands, Spain and the United Kingdom.
Other Boundaries	The detergent formulation, use and final disposal of the surfactants were not covered. The environmental effects associated with the manufacture of capital equipment and with energy and fuel requirements for plant and building conditioning (heat, air etc.) were not included, neither were those associated with personnel requirements. For electricity based on nuclear power and wind power, no emissions and resource exploits have been accounted for.
Allocations	Raw materials, energy and environmental emissions are allocated among co-products on an output weight basis, i.e. on the basis of mass. Co-products in this LCI include those materials that are currently recycled, reused or marketed in some beneficial way.
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study).

Flow Data

General Activity QMetaData

Date Conceived	1992
Data Type	
Represents	
Method	LC- inventory. Data from tables 7 to 10 pages 175-177 in lit. ref.
Literature Reference	Tenside Surfactant Detergents; 32. Jahrgang 2/95; Carl Hanser Verlag; Munchen
Notes	The raw material data are given in ''kg'' and the energy data are given in ''MJ''. However, it is important to remember that the raw materials themselves have an energy content.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Energy resource. The thermal value for coal is 27 MJ/kg.	Input	Natural resource	Coal	4428			MJ	Ground	

Notes: Energy resource. The thermal value for crude oil is 42 MJ/kg.	Input	Natural resource	Crude oil	3906			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Crude oil	613			kg	Ground	
Notes: Energy resource. The thermal value for natural gas is 45 MJ/kg.	Input	Natural resource	Natural gas	14220			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Natural gas	434			kg	Ground	
Notes: Raw material.	Input	Natural resource	Nitrogen	19			kg	Air	
Notes: Raw material.	Input	Natural resource	Oxygen	504			kg	Air	
Represents: Electricity produced by hydro power. Notes: Source of energy.	Input	Refined resource	Hydro power	340			MJ	Technosphere	
Represents: Electricity produced by nuclear power. Notes: Source of energy.	Input	Refined resource	Nuclear	2860			MJ	Technosphere	
	Output	Emission	Acid	62			g	Water	
	Output	Emission	Al	11			mg	Water	
	Output	Emission	Aldehydes	56			g	Air	
	Output	Emission	BOD	1.45			kg	Water	
	Output	Emission	CH4	15			g	Air	
	Output	Emission	Chloride	0.16			kg	Water	
	Output	Emission	Cl2	4.8			g	Air	
	Output	Emission	CO	1.3			kg	Air	
Notes: Fossil emissions of CO2. Non-fossil emissions do not exist for the process.	Output	Emission	CO2	2210			kg	Air	
	Output	Emission	COD	2.73			kg	Water	
	Output	Emission	Cr	7.3			g	Water	
	Output	Emission	Dissolved solids	1.51			kg	Water	
	Output	Emission	Fe	16			g	Water	
	Output	Emission	Fluoride	6.9			g	Water	
	Output	Emission	Fluorine	4.8			g	Air	
	Output	Emission	HC	11			g	Water	
	Output	Emission	HC	36.8			kg	Air	
	Output	Emission	HCl	0.11			kg	Air	
	Output	Emission	Metal ion	10			g	Water	
	Output	Emission	Metals	4.8			g	Air	
	Output	Emission	NH3	13			g	Air	
	Output	Emission	NH3	3.9			g	Water	
	Output	Emission	Ni	38			mg	Water	
	Output	Emission	NOx	16.6			kg	Air	
	Output	Emission	Oil	14			g	Water	
	Output	Emission	Other chemicals	0.15			kg	Water	
	Output	Emission	Other organics	0.52			kg	Air	
	Output	Emission	Particles	4.14			kg	Air	
	Output	Emission	Pb	5.3			mg	Air	
	Output	Emission	Phenol	5			g	Water	
	Output	Emission	Phosphates	2.6			g	Water	
	Output	Emission	SOx	11.7			kg	Air	
	Output	Emission	Sulphates	0.35			kg	Water	
	Output	Emission	Sulphides	29			g	Water	
	Output	Emission	Susp solids	0.16			kg	Water	
	Output	Emission	Zn	2.2			g	Water	
	Output	Product	Alcohol ethoxylate (7 EO)	1000			kg	Technosphere	
	Output	Residue	Solid waste	64.1			kg	Ground	

About Inventory

Publication	Tenside Surfactants Detergents, 32. Jahrgang 2/95 Carl Hanser Verlag, Munchen -- Data documented by: Malin Ericson, Akzo Nobel Surface Chemistry

	Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	All manufacturers and users of
General Purpose	-To produce an authoritative and comprehensive Life Cycle Inventory for major surfactant production in Europe through a common approach in order to facilitate objectivity in surfactant assessments on environmental grounds. -To secure the best possible validation of data and broad acceptance of the methodology and conclusions by industry, regulatory authorities, and academia, through assessment of the study by an appropriate expert review panel.
Detailed Purpose	-To establish an industry-wide inventory of the energy, emissions and resource exploits associated with the production of major surfactants in Western Europe under the conditions prevailing in 1992. -To bring together environmental data on the use of the main raw material sources - crude oil, natural gas, mineral, oleochemical, agricultural feedstock - for the processing pathways to the derived major surfactants. -To provide benchmarks for the processing steps of surfactant production against which individual producers can assess their own processes and identify opportunities for improvement. -To publish the results of the study and its conclusions in the open literature for access and reference by interested bodies.
Commissioner	- European LCI Surfactant Study Group (CEFIC/ECOSOL).
Practitioner	- Franklin Associates, Ltd. 4121 W. 83rd St., Suite 108 Prairie Village, KS 66208, USA.
Reviewer	Sundström Gustav - Miljöbalans Östra kennelvägen 35 237 35 Bjärred Sweden
Applicability	It is generally not possible to replace one surfactant type by another without changing other components of a preparation, or altering performance characteristics. Therefore, it is not in general meaningful to compare surfactants on a weight basis. Alcohols ethoxylates are the largest group of nonionic detergent range alcohols.The particular alcohol ethoxylate covered in this study is mainly used in detergents. Alcohol ethoxylates are less sensitive to water hardness compared to anionic surfactants.
About Data	13 industrial companies participated in the project, including major surfactant manufacturers, raw material and intermediate suppliers, as well as surfactant users in Europe, some of whom are both manufacturers and users. Participating companies are BASF, Colgate-Palmolive, Condea, Enichem Augusta, Henkel, Hoechst, Hüls, ICI, Petresa, Procter & Gamble, Shell, Unilever and Wibarco. Process data were obtained directly from each company performing the process. These data were often proprietary. Therefore, technical process data from private corporations were collected from a minimum of three producers for each intermediate and surfactant type. The information is presented in the form of industry averages in order to preserve confidentiality. Fuel-related data for European countries were based on various governmental statistics and industry contacts (aggregated and provided by Dr. I. Bousted, The Open University, UK).
Notes	Data for other surfactants such as Alcohol sulphates (AS), Alcohol ethoxy sulphates (AES), soap, Secondary alkane sulphonates (SAS), Linear alkylbenzene sulphonates (LAS) and Alkyl polyglucosides (APG) were given in the same study.

SPINE LCI dataset: Production of petrochemical Alcohol Sulphates (AS)

Administrative	
Finished	Y
Date Completed	1995-04-01
Copyright	Carl Hanser Verlag
Availability	Public

Technical System	
Name	Production of petrochemical Alcohol Sulphates (AS)

Functional Unit	1000 kg.
Functional Unit Explanation	All emissions, use of resources and energy consumption is based on 1000 kg of AS.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	BRIEF DESCRIPTION: The following steps are involved in the production of AS: Crude oil production: The study includes drilling, pumping and separation of crude oil from brine water and tank storage. Crude oil refining: The refining includes desalting, hydrotreating and distillation (fractionation/extraction of crude oil into paraffins, olefins, benzene and ethylene). Natural gas production: The study includes drilling, pumping and tank storage. Natural gas processing: No details were given. Ethylene production: Ethylene is produced form oil and natural gas. n-Paraffin production: N-paraffin is produced from oil. Olefins production: Olefins are produced from ethylene and n-paraffins. Alcohol production: The alcohols are produced from olefins and ethylene. The production includes the production of methyl esters requiring methanol made from natural gas. Sulphur production: Sulphur is used for the production of AS. No details were given on the production of sulphur. Salt production: Salt is used for the production of caustic soda. No details were given on salt production. Caustic soda production: Caustic soda is used in the production of AS: No details were given on the production of caustic soda. AS production: The process includes sulphonation of detergent range alcohols and neutralization with caustic soda. Information concerning all the subsystems described above: Transports are included in the system. The fuels for the transports and the fuels for the processes are traced back to the extraction of petrochemical raw materials and/or the extraction of bio fuels.. The electricity data are based on the electricity profile for each country and the petrochemical and biomass raw materials for electricity production are traced back to the extraction process (same process as for fuel raw materials).

System Boundaries

Nature Boundary	All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The process data used pertain mainly to 1992, being yearly averages where possible. It is recognised that operating processes and conditions are constantly evolving.
Geographical Boundary	This study examined the surfactant production in Europe, notably manufacturing processes conducted in Belgium, France, Germany, Italy, the Netherlands, Spain and the United Kingdom.
Other Boundaries	The detergent formulation, use and final disposal of the surfactants were not covered. The environmental effects associated with the manufacture of capital equipment and with energy and fuel requirements for plant and building conditioning (heat, air etc.) were not included, neither were those associated with personnel requirements. For electricity based on nuclear power and wind power, no emissions and resource exploits have been accounted for.

Allocations	Raw materials, energy and environmental emissions are allocated among co-products on an output weight basis, i.e. on the basis of mass. Co-products in this LCI include those materials that are currently recycled, reused or marketed in some beneficial way.
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study).

Flow Data

General Activity QMetaData

Date Conceived	1992
Data Type	Derived, unspecified
Represents	
Method	LC-inventory. Data can be found in tables 1 and 3-5 at pages 129-131 in lit.ref.
Literature Reference	Tenside Surfactants Detergents; 32. Jahrgang 2/1995; Carl Hanser Verlag; Munchen.
Notes	The raw material data are given in ''kg'' and the energy data are given in ''MJ''. However, it is important to remember that the raw materials themselves have an energy content.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Energy resource. Thermal value of coal is 27 MJ/kg.	Input	Natural resource	Coal	6290			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Crude oil	477			kg	Ground	
Notes: Energy resource. Thermal value of crude oil is 42 MJ/kg.	Input	Natural resource	Crude oil	5082			MJ	Ground	
Notes: Raw material.	Input	Natural resource	NaCl	113			kg	Ground	
Notes: Energy resource. The thermal value of natural gas is 45 MJ/kg.	Input	Natural resource	Natural gas	14130			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Natural gas	388			kg	Ground	
Notes: Raw material.	Input	Natural resource	Sulphur	113			kg	Ground	
Represents: Electricity produced by hydro power.	Input	Refined resource	Hydro power	370			MJ	Technosphere	
Represents: Electricity produced by nuclear power.	Input	Refined resource	Nuclear	2940			MJ	Technosphere	
	Output	Emission	Acid	0.086			kg	Water	
	Output	Emission	Al	12			mg	Water	
	Output	Emission	Alcohol Sulphates	1000			kg	Technosphere	
	Output	Emission	Aldehydes	0.01			kg	Air	
	Output	Emission	BOD	0.14			kg	Water	
	Output	Emission	CH4	0.0047			kg	Air	
	Output	Emission	Chloride	0.28			kg	Water	
	Output	Emission	Chlorine	0.01			kg	Air	
	Output	Emission	CO	1.63			kg	Air	
Notes: Fossil emissions of CO2. Non-fossil emissions of CO2 from the process do not exist.	Output	Emission	CO2	2524			kg	Air	
	Output	Emission	COD	1.62			kg	Water	
	Output	Emission	Cr	0.0018			kg	Water	
	Output	Emission	Dissolved solids	5.33			kg	Water	
	Output	Emission	Fe	0.031			kg	Water	
	Output	Emission	Fluorides	0.014			kg	Water	
	Output	Emission	Fluorine	0.01			kg	Air	
	Output	Emission	HC	0.014			kg	Water	
	Output	Emission	HC	29.1			kg	Air	
	Output	Emission	HCl	0.18			kg	Air	
	Output	Emission	HF	0.015			kg	Air	
	Output	Emission	Hg	0.3			g	Air	
	Output	Emission	Hg	28			mg	Water	
	Output	Emission	Metal ion	0.02			kg	Water	
	Output	Emission	Metals	0.01			kg	Air	
	Output	Emission	NH3	0.0088			kg	Water	

	Output	Emission	NH3	0.019			kg	Air	
	Output	Emission	Ni	71			mg	Water	
	Output	Emission	NOx	20.4			kg	Air	
	Output	Emission	Odorous sulphurs/thiols	0.39			mg	Air	
	Output	Emission	Oil	0.023			kg	Water	
	Output	Emission	Other chemicals	0.12			kg	Water	
	Output	Emission	Other organics	0.016			kg	Air	
	Output	Emission	Particles	5.91			kg	Air	
	Output	Emission	Pb	12			mg	Water	
	Output	Emission	Pb	4.9			mg	Air	
	Output	Emission	Phenol	0.01			kg	Water	
	Output	Emission	Phosphates	0.0032			mg	Water	
	Output	Emission	Solid waste	81.3			kg	Ground	
	Output	Emission	SOx	22.9			kg	Air	
	Output	Emission	Sulphates	4.82			kg	Water	
	Output	Emission	Sulphides	0.028			kg	Water	
	Output	Emission	Susp solids	0.2			kg	Water	
	Output	Emission	Zn	0.96			g	Water	

About Inventory	
Publication	Tenside Surfactants Detergents; 32. Jahrgang 2/1995; Carl Hanser Verlag; Munchen -- Data documented by: Malin Ericson, Akzo Nobel Surface Chemistry Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Manufacturers and user of surf
General Purpose	-To produce an authoritative and comprehensive Life Cycle Inventory for major surfactant production in Europe through a common approach in order to facilitate objectivity in surfactant assessments on environmental grounds. -To secure the best possible validation of data and broad acceptance of the methodology and conclusions by industry, regulatory authorities, and academia, through assessment of the study by an appropriate expert review panel.
Detailed Purpose	-To establish an industry-wide inventory of the energy and emissions associated with the production of major surfactants in Western Europe under the conditions prevailing in 1992. -To bring together environmental data on the use of the main raw material sources - crude oil, natural gas, mineral, oleochemical, agricultural feedstock - for the processing pathways to the derived major surfactants. -To provide benchmarks for the processing steps of surfactant production against which individual producers can assess their own processes and identify opportunities for improvement. -To publish the results of the study and its conclusions in the open literature for access and reference by interested bodies.
Commissioner	- European LCI Surfactant Study Group (CEFIC/ECOSOL).
Practitioner	- Franklin Associates, Ltd. 4121 W. 83rd St., Suite 108 Prairie Village, KS 66208, USA.
Reviewer	Klöppfer, Prof. Dr. W. - C.A.U. Consultants Frankfurt, Germany
Applicability	It is generally not possible to replace one surfactant type by another without changing other components of a preparation, or altering performance characteristics. Therefore, it is not in general meaningful to compare surfactants on a weight basis. It is estimated that approximately 40% of all detergent alcohols are transformed into alcohol sulphates. AS are also used in toiletry and cosmetic formulations such as schampoos, toothpastes and cosmetic lotions. The properties of AS are primarily determined by the molecular structure and chain lenth of the alcohol and the type of cation.
About Data	13 industrial companies participated in the project, including major surfactant manufacturers, raw material and intermediate suppliers, as well as surfactant users in Europe, some of whom are both manufacturers and users. Participating companies are BASF, Colgate-Palmolive, Condea, Enichem Augusta, Henkel, Hoechst, Hüls, ICI, Petresa, Procter & Gamble, Shell, Unilever and Wibarco. Process data were obtained directly from each company performing the process. These data were often proprietary. Therefore, technical process data from private corporations were collected from a minimum of three producers for each intermediate and surfactant type. The information is presented in the form of industry averages in order to preserve confidentiality. Fuel-related data for European countries were based on various governmental statistics and industry contacts (aggregated and provided by Dr. I. Bousted, The Open University, UK).

Notes	Data for other surfactants such as Linear alkylbenzene sulphonates (LAS), Alcohol ethoxy sulphates (AES), soap, Secondary alkane sulphonates (SAS), Alcohol ethoxylates (AE) and Alkyl polyglucosides (APG) were given in the same study.

SPINE LCI dataset: Production of phosphoric acid

Administrative	
Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public

Technical System	
Name	Production of phosphoric acid
Functional Unit	1 kg of phosphoric acid (55,5 % P2O5)
Functional Unit Explanation	
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	This dataset is intended to represent production of phosphoric acid that is used in the production of fertilisers at Hydro Agri AB in Köping. The data originate from reports on fertiliser production and no specific site has not been studied. The text below only gives general information about production of phosphoric acid, the data in this dataset do not necessarily represent these techniques. Further information about interpretations of what the data represent is given in the flow data window. This activity is also a part of the aggregated activity Production of NP 27-5 fertiliser AGGR. Production of phosphoric acid: As most phosphate ores have to be concentrated before they can be sold on the phosphate market and because different techniques may be used for doing this, the finished ore concentrate varies a great deal. This means that phosphoric acid technology, having to rely on raw materials of great variety, has to readapt itself constantly (BAT N° 4, 1995). There are several different process routes to produce phosphoric acid. The dihydrate (DH) process is the most diffused process (BAT N° 4, 1995). A dihydrate process can be considered to be made up by the following sections; grinding (not necessary for some phosphate ore, e.g. Kola rock), phosphoric reaction where gypsum is formed and filtration, where the product is separated from the gypsum crystals. The grinding is generally performed by ball or rod mills that can operate with both dry and wet rock. Wet rock is used for mineral-integrated unit operations, where rock beneficiation is achieved by washing or flotation. By feeding wet rock into the system, drying energy can be saved. The reaction of phosphate rock and sulphuric acid forming phosphoric acid and calcium sulphate (dihydrate form) takes place in an agitated single- or multitank. Ca3(PO4)2 + 3 H2SO4 ® 2 H3PO4 + 3 CaSO4 (s) The rock is initially kept in contact with recycled phosphoric acid to prevent an insoluble layer of calcium sulphate forming on the surface of the rock. a) Ca3(PO4)2 + 4 H3PO4 ® 3 Ca(H2PO4)2 b) 3 Ca(H2PO4)2+ 3 H2SO4 ® 3 CaSO4 (s) + 6 H3PO4 Calcium sulphate exists in a number of different crystal forms depending on temperature, P2O5 concentration and free sulphate content. In the production of phosphoric acid the operating conditions are generally selected so that the calcium sulphate is precipitated in either the dihydrate (CaSO4 . 2 H2O) or the hemihydrate (CaSO4 . 1/2 H2O) form (BAT N° 4, 1995). If operating conditions are selected so that the hemihydrate form is precipitated the phosphoric acid product will have a higher concentration of phosphorus than in the case

	of precipiting the dihydrate form. In the next stage phosphoric acid is separated from the calcium sulphate (gypsum) by filtration. Five tonnes of gypsum are generated for every tonne P2O5 of product acid produced. The phosphoric acid resulting from dihydrate operations yields 27-30 % P2O5 (Becker, 1989). Hemihydrate (HH) is also called the nonhydrate process and the main difference from the dihydrate process is that the calcium sulphate is participated in the hemihydrate form instead of the dihydrate form. The main advantage of this process is that evaporation heat requirements are reduced or eliminated due to the fact that an acid high in concentration is produced directly. Also, rock grinding requirements are lower because a satisfactory rate of reaction can be achieved from much coarser rock in the hemihydrate process. Disadvantages are e.g.; risk of slower filtration, phosphate losses and risk of corrosion due to a higher temperature and higher acid concentration than in the other processes (BAT N° 4, 1995). The weight of the produced gypsum is less than in the dihydrate process due to less water bound to each calcium sulphate molecule. Another method to obtain an acid high in concentration (40-52 % P2O5) directly, is by acidulating under hemihydrate conditions and separating the hemihydrate before recrystalling hemihydrate to dihydrate (HDH Process). The advantages of this method are energy savings due to the reduction or elimination of evaporation heat requirements, lower sulpuric acid consumption and that coarser rock can be used. It also produces a purer gypsum but the capital costs are high (BAT N° 4, 1995). The hemihydrate recrystalisation (HRC) process means acidulation under hemihydrate conditions and recrystallising to dihydrate without intermediate hemihydrate separation. This produces an acid of the same concentration as in the dihydrate process but the gypsum is much purer. This process consumes a lower quantity of sulphuric acid and a lower filter area but requires a fine rock grind and consumes evaporation heat (BAT N° 4, 1995). The dihemihydrate (DH/HH) process is another process. The method normally requires rock grinding and final rehydration of hemihydrate to dihydrate. The process produces a pure gypsum and consums a lower quantity of sulphuric acid (BAT N° 4, 1995). References: BAT N° 4 (1995). Production of Phosphoric Acid, Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry. EFMA - European Fertilizer Manufacturers' Association, Ave. E van Nieuwenhuyse 4, B-1160 Brussels, Belgium. Becker P (1989). Phosphates and Phosphoric Acid, Raw Materials, Technology and Economics of the Wet Process. Fertilizer Science and Technology Series-volume 6.

System Boundaries	
Nature Boundary	The system starts at the incoming factory gate and ends at the outgoing factory gate. Emissions and use of resources due to the production of steam and electricity are not included.
Time Boundary	The literature from which data are taken from is published in 1996 and 1998.
Geographical Boundary	Europe.
Other Boundaries	
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	Derived, unspecified
Represents	
Method	See ''Specific QMetaData''.
Literature Reference	Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. Patyk A (1996). International Conference on Application of Life Cycle Assessment in Agriculture, Food and Non-Food Agro Industry and Forestry: Achievements and Prospects. IFEU-Institut für Energie- und Umweltforschung Heidelberg; Wilkensstrasse 3, D-69120 Heidelberg, Germany.

Notes	No data from a specific site have been obtained. Therefore, data for energy consumption has been equalled to average data for production in Western Europe stated by Kongshaug (1998).

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: 100 % H2SO4.	Input	Natural resource	H2SO4	1.53			kg	Ground	Europe
Notes: 32 % P2O5. The rock phosphate used for production of the phosphoric acid that is used in Swedish fertiliser production originates from Finland and the source is igneous.	Input	Natural resource	Rock phosphate	1.73			kg	Ground	Europe
Method: According to Kongshaug (1998) the hemihydrate process is by far the most energy efficient process as the filter acid can be as high as 48-50 % P2O5. The dihydrate process produces a much weaker acid, resulting in a higher energy demand for evaporation. In Kongshaug (1998), a weighted value between the two levels of energy consumption has been calculated to produce an estimate of average energy consumption for production of phosphoric acid (54 % P2O5) in Western Europe today (Kongshaug, 1998). The figure given for an acid concentration of 54 % P2O5 has been chosen as representative for the concentration of 55.5 % as well, since the difference in energy consumption has been assumed to be of minor importance. The energy consumption given in Kongshaug (1998) corresponds well with figures given by Patyk (1996). A partition between the different energy sources steam and electricity for production of phosphoric acid used in Germany is given by Patyk (1996) and this partition has been assessed to be representative for the rest of Western Europe as well.	Input	Refined resource	Electricity	0.288			MJ	Technosphere	Europe
Method: According to Kongshaug (1998) the hemihydrate process is by far the most energy efficient process as the filter acid can be as high as 48-50 % P2O5. The dihydrate process produces a much weaker acid, resulting in a higher energy demand for evaporation. In Kongshaug (1998), a weighted value between the two levels of energy consumption has been calculated to produce an estimate of average energy consumption for production of phosphoric acid (54 % P2O5) in Western Europe today (Kongshaug, 1998). The figure given for an acid concentration of 54 % P2O5 has been chosen as representative for the concentration of 55.5 % as well, since the difference in energy consumption has been assumed to be of minor importance. The energy consumption given in Kongshaug (1998) corresponds well with figures given by Patyk (1996). A partition between the different energy sources steam and electricity for production of phosphoric acid used in Germany is given by Patyk (1996) and this partition has been assessed to be representative for the rest of Western Europe as well.	Input	Refined resource	Steam	3.6			MJ	Technosphere	Europe
	Output	Emission	Fluoride	0.133			g	Air	Europe
Notes: 55,5 % P2O5.	Output	Product	Phosphoric acid	1			kg	Technosphere	Europe
Notes: Mainly calcium sulphate (CaSO4).	Output	Residue	Gypsum	2.75			kg	Technosphere	Europe

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and

	Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources due to the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other, but to generate a thorough inventory of emissions and use of resources due to this production. Production of phosphoric acid is one step in the line of production of fertilisers containing phosphorus produced at Hydro Agri AB in Köping. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The dataset is applicable for production of phosphoric acid used in fertiliser production at Hydro Agri AB in Köping, Sweden. The phosphoric acid that is used in this production is imported from Kemira Chemicals OY in Siilinjärvi, Finland. The concentration of the acid delivered to Hydro Agri AB, Köping, is 55-56 % P2O5 and a concentration of 55.5 % has therefore been assumed. No was obtained for this specific production site, data have therefore been taken from literature. The dataset is included in aggregated datasets for fertiliser production at Hydro Agri AB in Köping (cradle to gate).
About Data	Data are gathered from literature, i.e. no specific site has been studied.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of phosphoric acid (48 % P2O5)

Administrative	
Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public

Technical System	
Name	Production of phosphoric acid (48 % P2O5)
Functional Unit	1 kg of phosphoric acid (48 % P2O5)
Functional Unit Explanation	1 kg P2O5 = 0,4364 kg P.
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	This dataset is intended to represent production of phosphoric acid that is used in the production of fertilisers used in Western Europe. The data originate from reports on fertiliser production and no specific site has not been studied. The text below only gives general information about production of phosphoric acid, the data in this dataset do not necessarily represent these techniques. Further information about interpretations of what the data represent is given in the flow data window.

As most phosphate ores have to be concentrated before they can be sold on the phosphate market and because different techniques may be used for doing this, the finished ore concentrate varies a great deal. This means that phosphoric acid technology, having to rely on raw materials of great variety, has to readapt itself constantly (BAT N° 4, 1995).

There are several different process routes to produce phosphoric acid. The dihydrate (DH) process is the most diffused process (BAT N° 4, 1995). A dihydrate process can be considered to be made up by the following sections; grinding (not necessary for some phosphate ore, e.g. Kola rock), phosphoric reaction where gypsum is formed and filtration, where the product is separated from the gypsum crystals. The grinding is generally performed by ball or rod mills that can operate with both dry and wet rock. Wet rock is used for mineral-integrated unit operations, where rock beneficiation is achieved by washing or flotation. By feeding wet rock into the system, drying energy can be saved. The reaction of phosphate rock and sulphuric acid forming phosphoric acid and calcium sulphate (dihydrate form) takes place in an agitated single- or multitank.

$Ca_3(PO_4)_2 + 3 H_2SO_4$ ® $2 H_3PO_4 + 3 CaSO_4$ (s)

The rock is initially kept in contact with recycled phosphoric acid to prevent an insoluble layer of calcium sulphate forming on the surface of the rock.

a) $Ca_3(PO_4)_2 + 4 H_3PO_4$ ® $3 Ca(H_2PO_4)_2$

b) $3 Ca(H_2PO_4)_2 + 3 H_2SO_4$ ® $3 CaSO_4$ (s) $+ 6 H_3PO_4$

Calcium sulphate exists in a number of different crystal forms depending on temperature, P_2O_5 concentration and free sulphate content. In the production of phosphoric acid the operating conditions are generally selected so that the calcium sulphate is precipitated in either the dihydrate ($CaSO_4 . 2 H_2O$) or the hemihydrate ($CaSO_4 . 1/2 H_2O$) form (BAT N° 4, 1995). If operating conditions are selected so that the hemihydrate form is precipitated the phosphoric acid product will have a higher concentration of phosphorus than in the case of precipiting the dihydrate form.

In the next stage phosphoric acid is separated from the calcium sulphate (gypsum) by filtration. Five tonnes of gypsum are generated for every tonne P_2O_5 of product acid produced. The phosphoric acid resulting from dihydrate operations yields 27-30 % P_2O_5 (Becker, 1989).

Hemihydrate (HH) is also called the nonhydrate process and the main difference from the dihydrate process is that the calcium sulphate is participated in the hemihydrate form instead of the dihydrate form. The main advantage of this process is that evaporation heat requirements are reduced or eliminated due to the fact that an acid high in concentration is produced directly. Also, rock grinding requirements are lower because a satisfactory rate of reaction can be achieved from much coarser rock in the hemihydrate process. Disadvantages are e.g.; risk of slower filtration, phosphate losses and risk of corrosion due to a higher temperature and higher acid concentration than in the other processes (BAT N° 4, 1995). The weight of the produced gypsum is less than in the dihydrate process due to less water bound to each calcium sulphate molecule.

Another method to obtain an acid high in concentration (40-52 % P_2O_5) directly, is by acidulating under hemihydrate conditions and separating the hemihydrate before recrystalling hemihydrate to dihydrate (HDH Process). The advantages of this method are energy savings due to the reduction or elimination of evaporation heat requirements, lower sulpuric acid consumption and that coarser rock can be used. It also produces a purer gypsum but the capital costs are high (BAT N° 4, 1995).

The hemihydrate recrystalisation (HRC) process means acidulation under hemihydrate conditions and recrystallising to dihydrate without intermediate hemihydrate separation. This produces an acid of the same concentration as in the dihydrate process but the gypsum is much purer. This process consumes a lower quantity of sulphuric acid and a lower filter area but requires a fine rock grind and consumes evaporation heat (BAT N° 4, 1995).

The dihemihydrate (DH/HH) process is another process. The method normally requires rock grinding and final rehydration of hemihydrate to dihydrate. The process produces a pure gypsum and consums a lower quantity of sulphuric acid (BAT N° 4, 1995).

References:
BAT N° 4 (1995). Production of Phosphoric Acid, Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry. EFMA - European Fertilizer Manufacturers' Association, Ave. E van Nieuwenhuyse 4, B-1160 Brussels, Belgium.

Becker P (1989). Phosphates and Phosphoric Acid, Raw Materials, Technology and Economics of the Wet Process. Fertilizer Science and Technology Series-volume 6.

Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998.

System Boundaries

Nature Boundary	The system starts at the incoming factory gate and ends at the outgoing factory gate. Emissions and use of resources due to the production of steam and electricity are not included.
Time Boundary	The literature from which data are taken from is published in 1996 and 1998.
Geographical Boundary	Europe.
Other Boundaries	
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	
Method	Data are taken from literature and reports on fertiliser production. No specific site has been studied. See also ''Specific QMetaData''.
Literature Reference	BAT N° 4 (1995). Production of Phosphoric Acid, Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry. EFMA - European Fertilizer Manufacturers' Association, Ave. E van Nieuwenhuyse 4, B-1160 Brussels, Belgium. Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. Patyk A (1996). International Conference on Application of Life Cycle Assessment in Agriculture, Food and Non-Food Agro Industry and Forestry: Achievements and Prospects. IFEU-Institut für Energie- und Umweltforschung Heidelberg; Wilkensstrasse 3, D-69120 Heidelberg, Germany. Personal communication: Steen I (1998). Group Agronomist, Kemira Agro, Copenhagen, Denmark. E-mail: Ingrid.Steen@kemira.com
Notes	

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: According to Kongshaug (1998) the hemihydrate process is by far the most energy efficient process as the filter acid can be as high as 48-50 % P2O5. The dihydrate process produces a much weaker acid, resulting in a higher energy demand for evaporation. In Kongshaug (1998), a weighted value between the two levels of energy consumption has been calculated to produce an estimate of average energy consumption for production of phosphoric acid (54 % P2O5) in Western Europe today (Kongshaug, 1998). A large part of the phosphoric acid consumed in Western Europe is imported from countries outside Western Europe, e.g. Morocco and it has been assumed that production techniques in these countries are comparable to production in Western Europe (Steen pers. comm., 1998). The energy consumption for production phosphoric acid is 3.8 GJ/t H3PO4 (54 % P2O5). The energy consumption for production of phosphoric acid (48 % P2O5) is 1 GJ/t P2O5 lower, as less energy for evaporation is needed, which results in 2.9 GJ/t H3PO4 (48 % P2O5) (Kongshaug, 1998). The energy consumption given in Kongshaug (1998) corresponds well with figures given by Patyk (1996). A partition between the different energy sources steam and electricity for production of phosphoric acid used in Germany is given by Patyk (1996)	Input	Refined resource	Electricity	0.213			MJ	Technosphere	Europe

and this partition has been assessed to be representative for the rest of Western Europe as well. With the energy consumption given by Kongshaug (1998) and the partition given by Patyk (1996), a resulting energy consumption of 2.7 GJ steam/t H3PO4 (48 % P2O5) and 0.2 GJ electricity/t H3PO4 (48 % P205) has been assumed to be representative for production of phosphoric acid used in Western Europe. The steam has been assumed to be produced by combustion of oil.									
Method: The consumption of sulphuric acid is assumed to be 1.49 t H2SO4 (100 %)/t phosphoric acid (54 % P2O5) as given in Kongshaug (1998). Notes: 100 % H2SO4.	Input	Refined resource	H2SO4	1.33			kg	Technosphere	Europe
Method: The amount of ore (32 % P2O5) that has to be dissolved to produce one tonne of phosphoric acid (48 % P2O5) is 1.5 t/t phosphoric acid. It has been assumed that no phosphorus is intergrown in the gypsum waste. In reality this is not true since 1.5-7 % of the phosphorus may end up in the gypsum depending on which process that has been used (Fertilizer Manual, 1998). Notes: Commercial rock phosphate; 32 % P2O5.	Input	Refined resource	Rock phosphate	1.5			kg	Technosphere	Europe
Method: According to Kongshaug (1998) the hemihydrate process is by far the most energy efficient process as the filter acid can be as high as 48-50 % P2O5. The dihydrate process produces a much weaker acid, resulting in a higher energy demand for evaporation. In Kongshaug (1998), a weighted value between the two levels of energy consumption has been calculated to produce an estimate of average energy consumption for production of phosphoric acid (54 % P2O5) in Western Europe today (Kongshaug, 1998). A large part of the phosphoric acid consumed in Western Europe is imported from countries outside Western Europe, e.g. Morocco and it has been assumed that production techniques in these countries are comparable to production in Western Europe (Steen pers. comm., 1998). The energy consumption for production phosphoric acid is 3.8 GJ/t H3PO4 (54 % P2O5). The energy consumption for production of phosphoric acid (48 % P2O5) is 1 GJ/t P2O5 lower, as less energy for evaporation is needed, which results in 2.9 GJ/t H3PO4 (48 % P2O5) (Kongshaug, 1998). The energy consumption given in Kongshaug (1998) corresponds well with figures given by Patyk (1996). A partition between the different energy sources steam and electricity for production of phosphoric acid used in Germany is given by Patyk (1996) and this partition has been assessed to be representative for the rest of Western Europe as well. With the energy consumption given by Kongshaug (1998) and the partition given by Patyk (1996), a resulting energy consumption of 2.7 GJ steam/t H3PO4 (48 % P2O5) and 0.2 GJ electricity/t H3PO4 (48 % P205) has been assumed to be representative for production of phosphoric acid used in Western Europe. The steam has been assumed to be produced by combustion of oil.	Input	Refined resource	Steam	2.67			MJ	Technosphere	Europe
Method: Concerning emissions of fluorine, the achievable emission level of fluorine for existing plants according to (BAT N° 4, 1995) has been assessed to be representative for the production of phosphoric acid used in Western Europe. The reason for using this emission level	Output	Emission	Fluoride	0.115			g	Air	Europe

was lack of average data.									
Notes: 48 % P2O5.	Output	Product	Phosphoric acid	1			kg	Technosphere	Europe
Method: Concerning generation of gypsum, the achievable emission level of gypsum for existing plants according to (BAT N° 4, 1995) has been assessed to be representative for the production of phosphoric acid used in Western Europe. The reason for using this emission level was lack of average data. Notes: Mainly calcium sulphate (CaSO4).	Output	Residue	Gypsum	2.4			kg	Technosphere	Europe

About Inventory	
Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources due to the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other, but to generate a thorough inventory of emissions and use of resources due to this production. Production of phosphoric acid is one step in the line of production of some fertilisers containing phosphorus. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The dataset is applicable for production of phosphoric acid used in production of fertilisers consumed in Western Europe. The dataset is included in aggregated datasets (cradle to gate) for production of fertilisers containing phosphorus used in Western Europe (e.g. triple superphosphate).
About Data	Data are gathered from literature, i.e. no specific site has been studied.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of pig iron

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Production of pig iron
Functional Unit	0,2664 kg pig iron

Functional Unit Explanation	
Process Type	Gate to gate
Site	SSAB Luleå
Sector	Materials and components
Owner	SSAB Luleå
Technical system description	This activity describes a process step included in the system ''Production of guide rings used for spherical roller bearings'', also available in the SPINE@CPM database. The pig iron will be used as raw material for the production of guide rings at SKF Mekan AB in Katrineholm. The guide rings will later be mounted into the SKF Spherical Roller Bearing 232/530. The function is to assure that the rollers stay in the raceways of the bearing. Pig iron is produced in Russia and is transported with freighter and truck to SKF Mekan AB in Katrineholm. The raw material is iron ore which is smelted in a blast furnace and rolled into billets. Since no information was available from the Russian producer, this dataset refer to production of pig iron at SSAB in Luleå, Sweden. The data for the calculations is obtained from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.

System Boundaries

Nature Boundary	Not known.
Time Boundary	Not known.
Geographical Boundary	The process takes place at SSAB in Luleå, Sweden
Other Boundaries	Not known.
Allocations	Allocations were made according to weight
Systems Expansions	Not Applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	
Method	This dataset refer to production of pig iron at SSAB in Luleå, Sweden. Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Blast furnace gas	3.121e+005			J	Technosphere	
	Input	Refined resource	Briquets (recycled material)	0.01128			kg	Technosphere	
	Input	Refined resource	Coke dust	0.879			kg	Technosphere	Sweden
	Input	Refined resource	Coke gas	1.56e+005			J	Technosphere	Sweden
	Input	Refined resource	Electricity	8.63e+004			J	Technosphere	Sweden
	Input	Refined resource	Fe-pellets	0.3617			kg	Technosphere	
	Input	Refined resource	Hard coal	3.49E-2			kg	Ground	
	Input	Refined resource	LD-slag	9.70E-3			kg	Technosphere	
	Input	Refined resource	Limestone	1.52e-2			kg	Ground	
	Input	Refined resource	Oxygen	9.18E-12			m3	Technosphere	
	Input	Refined resource	Slag	1.31E-3			kg	Technosphere	
	Input	Refined resource	Steam	4720			J	Technosphere	Sweden
	Output	Emission	CO2	0.1574			kg	Air	

	Output	Emission	Cr	7.87E-10		kg	Air	
	Output	Emission	NH4+ as N	1.15E-6		kg	Water	
	Output	Emission	Ni	2.89E-9		kg	Air	
	Output	Emission	NOx	7.08E-6		kg	Air	
	Output	Emission	Particles	1.23E-5		kg	Air	
	Output	Emission	Pb	2.62E-10		kg	Air	
	Output	Emission	Pb	5.25E-10		kg	Water	
	Output	Emission	SO2	3.15E-5		kg	Air	
	Output	Emission	Zn	1.57e-008		kg	Water	
	Output	Emission	Zn	4.98E-9		kg	Air	
	Output	Product	Pig iron	0.2663		kg	Technosphere	
	Output	Residue	Slag	0.04511		kg	Technosphere	

About Inventory	
Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The dataset is valid for production of pig iron at SSABs site in Luleå, Sweden.
About Data	This dataset refer to production of pig iron at SSAB in Luleå, Sweden. Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	

SPINE LCI dataset: Production of pig iron - blast furnace process. ESA-DBP

Administrative	
Finished	Y
Date Completed	1996
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Production of pig iron - blast furnace process. ESA-DBP
Functional Unit	1 kg of pig iron
Functional Unit Explanation	

Process Type	Gate to gate
Site	Unknown
Sector	Mining and quarrying
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''The blast furnace is fed with ore, sinter, coke, lime and several minor inputs. The mass is heated and the ore is reduced by the carbon in the coke and by carbon monoxide produced by partial combustion of the coke. The pig iron is created at about 1700 'C. The sources of air pollution from the blast furnace are blast furnace gas, cast house emissions, slag handling and procesing. The rate of gas production is linked to smelting efficiency. The fume emissions from the cast house arises as a result from vaporisation of exposure to air and oxidation.'' This process is included in the system described in: Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Coal mining and cleaning. ESA-DBP - Cast iron production. ESA-DBP - Limestone quarrying. ESA-DBP - Sand extraction and processing. ESA-DBP - Sinter plant's process ESA-DBP - Uranium ore extraction and enrichment. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) and emissions to air and water.
Time Boundary	1982-1986
Geographical Boundary	United Kindom
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1982-1986
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other report.
Literature Reference	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Data for particular process come from: Boustead I. and Hancock G.F. (1982), Energy and Recycling in Steel Production Systems, Resources and Conservation, 9, 209-218, Elsevier Scientific Publishing Company United Nations Environment Programme (UNEP) (1986), Environmental Aspects of Iron and Steel Production, A Technical Review, Industry & Environment Office
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Coke	5.89E-01			kg	Ground	United Kingdom
	Input	Refined resource	Electricity	6.00E-02			MJ	Technosphere	United Kingdom
	Input	Refined resource	Heat	1.29E+01			MJ	Technosphere	United Kingdom
	Input	Refined resource	Manganese	2.08E-02			kg	Ground	United Kingdom
	Input	Refined resource	Sinter	1.58E+00			kg	Ground	United Kingdom
	Output	Emission	CO	1.00E-02			kg	Air	United Kingdom
	Output	Emission	COD	6.00E-04			kg	Water	United Kingdom
	Output	Emission	NO2	5.00E-04			kg	Air	United Kingdom

	Output	Emission	Particulates	9.16E-03			kg	Air	United Kingdom
	Output	Emission	SO2	2.00E-04			kg	Air	United Kingdom
	Output	Emission	Susp solids		1.20E-03	6.00E-03	kg	Water	United Kingdom
	Output	Product	Pig iron	1.00E+00			kg	Technosphere	United Kingdom

About Inventory

Publication	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The aim of the study is to undertake an LCA of typical water and sewage pumps. Those aspects which have a major contribution to the environmental impact in the life cycle of a pump will be identified.''
Detailed Purpose	Cast iron is a main material in a water pump (90%).
Commissioner	Unknown - .
Practitioner	Johanna Thuresson - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Production of plastic strips and film

Administrative

Finished	Y
Date Completed	1996-03-01
Copyright	
Availability	Public

Technical System

Name	Production of plastic strips and film
Functional Unit	ton
Functional Unit Explanation	1 ton produced plastic strips and film
Process Type	Gate to gate
Site	Järund Inventering AB Box 44 450 71 Fjällbacka Sweden
Sector	Materials and components
Owner	Järund Inventering AB Box 44 450 71 Fjällbacka Sweden

Technical system description	The company produces plastic strips and films. The products are manufactured in the following lines. Monoblister film Two production lines are in order to produce monoblister film. The main raw material used is LD-polyethylene. The plastic is treated in an extruder at 160-180 deg C, and is divided by a tool, from which the plastic is shaped into a blister. the blister is led up to the cealing where it is pulled off so that the film is cooled and flattened. The film is cut and rolled on to a roll. Coextruderad plane film The raw material, consisting of HD-polyethylene and LD-polyethylene, is worked together at a temperature of 200-220 deg C. The film is shaped and rolled on to a roll, where it is cut and wound. Extrution coating Thinn polyester film is treated and covered with primer. Primer, hardener and solvents are mixed and are pumped to the production line in a closed system. The primer is dryed in drying tunnel, and the solvent is combustioned catalyticly. The dry film is then covered with LD-polyethylene at a temperature of 280-320 deg C. Plastic smoke is made at the high temperature. The smoke is combusted in the compustion plant. Coextrusion blister film The raw material is worked at a temperature of 180-220 deg C in five different vessels. The materials are shaped and are brought together with a five layer tool. The film blister is lifted upp from a ring shaped mouthpiece and is cooled by large amounts of air, from a cooling ring around the tool. A rotating roll pulls off flattens the film at 17 meter above the ground. The film is then rolled upp again on rolls. Other Production Films are cut into plastic strips in approx. 30 cutting machines. Covers for thermometers are made of plastic film. Plastic film made of poly propylene is covered with a mixture of glue and chloric salt. UV-enamel is put on the product as protection. The use of fuel is limited by recycling of heat in the processes.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	The waste paper consisting of pasteboard and cardboard is gathered for material recycling. The waste paper is transported by Tanums Lastbilscentral. the amount of waste paper is not stated in the environmental report.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified
Represents	See 'Function'
Method	Study the Environmental report The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1995, which was 4600 ton plastic strips and films.
Literature Reference	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Data for particular process come from: Boustead I. and Hancock G.F. (1982), Energy and Recycling in Steel Production Systems, Resources and Conservation, 9, 209-218, Elsevier Scientific Publishing Company United Nations Environment Programme (UNEP) (1986), Environmental Aspects of Iron and Steel Production, A Technical Review, Industry & Environment Office
Notes	The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Electricity	1.02			MWh	Technosphere	
	Input	Refined resource	Ethylenevinylalcohol	0.015869565			tonne	Technosphere	
Date concieved: 1995 Notes: Used in the combustion plant	Input	Refined resource	Fuel gas	0.00173913			tonne	Technosphere	
Date concieved: 1995 Notes: The use of fuel oil is limited by recycling of heat from the processes.	Input	Refined resource	Fuel oil	0.004021739			m3	Technosphere	
	Input	Refined resource	HDPE	0.186304348			tonne	Technosphere	
Date concieved: 1995 Notes: 0,423% consist of butyl akrylate	Input	Refined resource	LDPE	0.873478261			tonne	Technosphere	
Date concieved: 1995 Notes: (Polymer adhesive)	Input	Refined resource	LLDPE	0.022173913			tonne	Technosphere	
	Input	Refined resource	Masterbatcher	0.000869565			tonne	Technosphere	
Notes: (Solvent)	Input	Refined resource	Methyl ketone	0.063478261			tonne	Technosphere	
Date concieved: 1995 Notes: Municipal water is used for lavatories and washing facilities.	Input	Refined resource	Municipal water	0			m3	Technosphere	
	Input	Refined resource	Polyester	0.145652174			tonne	Technosphere	
Date concieved: 1995 Notes: Of the concentration 27%.	Input	Refined resource	Polyurethaneprimer	0.024347826			tonne	Technosphere	
	Input	Refined resource	PP	0.001956522			tonne	Technosphere	
Date concieved: 1995 Data type: Estimated Method: The amount is approximated	Output	Emission	Plastic smoke	0.108695652			kg	Air	
Date concieved: 1995 Data type: Estimated Notes: The emissions consist of solvents (MEK) and toluene. The amount is approximated	Output	Emission	Solvents	0.054347826			kg	Air	
Date concieved: 1995 Notes: The industrial waste is transported by Tanums Lastbilscentral.	Output	Residue	Industrial waste	0.26087			m3	Technosphere	
	Output	Residue	Other rest products	0.260869565			m3	Technosphere	
Notes: The waste plastics (mostly polyethene) consists of 50,6% Polyethene 41,1% Polyethene/Polyester 8,33% Polyethene/ethylene vinylalcohol The polyethene waste is sold to be recycled and refined into raw material.	Output	Residue	Plastics	0.182608696			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Also contains chloric salt Hazardous for the environment. The waste is transported by GRAAB to SAKAB for final disposal.	Output	Residue	Waste glue	0.261130435			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Hazardous for the environment.	Output	Residue	Waste oil	0.261130435			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Hazardous for the environment. The waste is transported by GRAAB to SAKAB for final disposal.	Output	Residue	Waste petroleum jelly	0.0271516304			kg	Technosphere	

Date concieved: 1996 Data type: Unspecified Notes: Hazardous for the environment. The waste is transported by GRAAB to SAKAB for final disposal.	Output	Residue	Waste primers	0.781907609			kg	Technosphere	
Notes: Hazardous for the environment. The waste is transported by GRAAB to SAKAB for final disposal.	Output	Residue	Waste solvents	1.483695652			kg	Technosphere	

About Inventory	
Publication	The environmental report from Järund inventering AB for 1995, The Board of County in Göteborg and Bohus --- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden.
Practitioner	Järund, Erik - Järund Inventering AB Box 44 450 71 Fjällbacka Sweden.
Reviewer	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden
Applicability	
About Data	
Notes	

SPINE LCI dataset: Production of plywood boxes

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Production of plywood boxes
Functional Unit	One plywood box: 52,61 kg
Functional Unit Explanation	One Plywood box (Nefab ExPak type-S, 1160 x 1160 x H) weighs 52,61 kg. This box is used to transport the SKF spherical roller bearing 232/530 from SKFs site in Göteborg to customers around the world.
Process Type	Cradle to gate
Site	Nefab Emballage ABNordgrens väg 5 822 92 ALFTA SWEDEN
Sector	Materials and components

Owner	Nefab Emballage ABNordgrens väg 5 822 92 ALFTA SWEDEN
Technical system description	Plywood boxes are used to pack the coated and non-coated roller bearings from SKF, Göteborg, during the transportation to customers. The plywood boxes are manufactured by Nefab Emballage AB in Alfta, Sweden. This dataset includes the following process steps: (all eight are available in the SPINE@CPM database) 1. Plywood production 2. Virgin Steel Production 3. Hot rolling of steel sheet 4. Pickled hot rolled steel sheet 5. Cold reducing of steel sheets 6. Metal coating of cold reduced steel sheets 7. Production of wood 8. Manufacturing of plywood boxes at Nefab in Alfta The transports included in this dataset are: A. Transportation of rawmaterial for plywood production in Russia B. Transport by truck, train and freighter of plywood from Russia to Alfta in Sweden. C. Transport by truck of steel from Borlänge to Alfta. D. Transport by truck of wooden splits from local sawmill to Alfta. E. Transport by truck of steel nails from Uddevalla to Alfta. All production of electricity is included in the dataset. Also production of other energy carrier (Diesel, LPG, Heavy fuel oil) is included in the dataset and should not be taken into account. The plywood boxes consist of the following parts: Contents per box Weight (kg) % of total weight Plywood 33.9 64.44 Wooden splits 14.9 28.32 Steel strips 3.7 7.03 Steel nails 0.108 0.21 1. Production of plywood Plywood is built by wooden veneer sheets, which are crossed and put together through gluing. Characteristic of plywood is very high durability comparing to weight. Nefab Emballage AB uses plywood (birch wood) from different production plants in St Petersburg, Russia, but no LCI data was available from their Russian suppliers. Instead data for Swedish plywood (pine wood) is used. The used data refers to an EPD of wooden based board, 7 mm pinewood, produced by Edsbyn Träförädling AB [Environmental Product Declaration from Trätek, Sweden -9709077; 1997]. The inventory starts from extraction of resources and ends at the gate of the company. The raw material for the plywood production must be transported to the production plants in Russia. This has been included in the study and data is obtained from an LCA made at Nefab Emballage AB [Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000.]. Also the transport from Russia to Alfta in Sweden is considered and calculated from above mentioned study. The packaging material however is not included. 2. Virgin Steel Production Steel nails are used to attach the wooden splits to the plywood box. Steel strips are used to make the box more durable and lasting. Scanfast AB in Uddevalla, Sweden, supplies the steel nails and Tibnor AB in Borlänge, Sweden supplies the steel strips. All material from the suppliers to Nefab Emballage AB in Alfta is assumed to be transported by truck. For the steel production of all steel used in the plywood box, data from an earlier LCA study is used [Maria Sunér; Life Cycle Assessment of Aluminium, Copper and Steel; Technical Environmental Planning; Report 1996:6; Chalmers University of Technology; Gothenburg; Sweden] This dataset is obtained from the SPINE@CPM database. 3. Rolling of steel 4. Pickled hot rolled steel sheets 5. Cold reducing of steel sheets 6. Metal coating of cold reduced steel sheets When producing the steel strips, the steel from the steel mill is hot rolled, pickled, cold reduced and finally coated at SSAB Tunnplåt`s line in Borlänge. All data for these processes is obtained from an already made LCA at Nefab Emballage AB. The data refers mostly to existing EPDs from SSAB Tunnplåt AB. The steel nails are assumed not to be coated and thus the only process included after the production of steel is hot rolling of steel sheets. 7. Production of wooden splits Wooden splits are attached to the bottom of the box to enable forklift handling. Nefab Emballage AB buys the wooden splits from a local sawmill, Alfta Pall AB, in Alfta, Sweden. The database in LCAiT - production of 1 kg of wood for package use in Sweden - is used [Tillman et al., Chalmers Industriteknik, Gothenburg, Sweden, 1992. Packaging and the Environment, Tillman et al., Chalmers Industriteknik, Gothenburg, Sweden, 1992.]. The

	data includes transports and extraction of raw material. 8. Manufacturing of plywood boxes at Nefab in Alfta At Nefab Emballage AB in Alfta the plywood box is mounted, from its ingoing parts: Plywood, Steel strips, Wooden splits and steel nails. The used data refers to an EPD from Nefab Emballage AB for the product NEFAB Expak [Environmental Product Declaration from NEFAB Emballage AB; Doc.no.5-073-103.]. The environmental profile includes emissions from local energy use and internal transportation. The presumed product in the EPD contains plywood (87%) and steel strip (13%).

System Boundaries

Nature Boundary	Emissions to air and to water are included. The steel used for the steel strips and the nails are assumed to be virgin steel, and is followed from the cradle. See under each separate subactivity in Function for more detailed information.
Time Boundary	The data is gathered during the autumn 2002 and no changes in the procedure are planned for the nearest future. See under each separate subactivity in Function for more detailed information.
Geographical Boundary	The plywood production takes place at different suppliers in the area around St Petersburg, Russia. Production of steel and wood take place in Sweden. The final production of the plywood box takes place at Nefab Emballage AB in Alfta, Sweden.
Other Boundaries	All production of electricity is included in the dataset. Also production of other energy carrier (Diesel, LPG, Heavy fuel oil) is included in the dataset and should not be taken into account. This includes also the transports. The transports included in this dataset are: A. Transportation of rawmaterial for plywood production in Russia (plywood, 100 km by truck and 500 km by train), (glue, 300 km by train) B. Transport by truck, train and freighter of plywood from Russia to Alfta in Sweden. (truck 467 km, diesel train 77 km, electric train 283 km, freighter 224 km) C. Transport by truck of steel from Borlänge to Alfta. (114 km) D. Transport by truck of wooden splits from local sawmill to Alfta. (50 km) E. Transport by truck of steel nails from Uddevalla to Alfta. (570 km)
Allocations	Allocations have been made according to weight and composition from ingoing components (%).
Systems Expansions	Not Applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'
Method	The data is gathered from interviews with Kjell-Arne Jonsson at Nefab Emballage AB in Alfta. Much of the data is taken from earlier LCA studies. See under the sub activities for more detailed information. Distances and type of transportations are taken from: * Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. * Weström Pär, Packforsk Consulting AB; Simplified life cycle assessment for the comparison of two packaging alternatives for medium-sized roller bearings; Report no. C00 528; April 2001.
Literature Reference	* Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. * Weström Pär, Packforsk Consulting AB; Simplified life cycle assessment for the comparison of two packaging alternatives for medium-sized roller bearings; Report no. C00 528; April 2001. * Environmental Product Declaration from NEFAB Emballage AB; Doc.no.5-073-103.
Notes	The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Copper in ore	7.478e-005			kg	Ground	
	Input	Natural resource	Iron in ore	0.0003691			kg	Ground	
	Input	Natural resource	Lead in ore	1.329e-006			kg	Ground	

		Input	Natural resource	Surface water	3.564e-009			kg	Ground	
		Input	Natural resource	Uranium in ore	0.0006106			kg	Ground	
		Input	Natural resource	Uranium ore	3.546e-005			kg	Ground	
		Input	Refined resource	Al	0.000629			kg	Ground	
		Input	Refined resource	Alloy ore	0.0694			kg	Other	
		Input	Refined resource	Aluminium	7.858e-006			kg	Technosphere	
		Input	Refined resource	Bauxite	0.03749			kg	Other	
		Input	Refined resource	Bentonite	0.03369			kg	Other	
		Input	Refined resource	Bentonite	5.183e-005			kg	Ground	
		Input	Refined resource	Biomass	1.897			kg	Ground	
		Input	Refined resource	Chalice	0.008646			kg	Other	
		Input	Refined resource	Chalk	1.377e-005			kg	Ground	
		Input	Refined resource	Clay	2.949e-006			kg	Ground	
		Input	Refined resource	Coal	2.861			kg	Other	
		Input	Refined resource	Crude oil	5.474			kg	Ground	
		Input	Refined resource	Crude oil, feedstock	6.541e-007			kg	Ground	
		Input	Refined resource	Diesel	0.000271			kg	Other	
		Input	Refined resource	Dolomite	3.497e-006			kg	Other	
		Input	Refined resource	Electricity	0.004924			MJ	Other	
		Input	Refined resource	Electricity	11.07			MJ	Technosphere	
		Input	Refined resource	Emulsifier	5.622e-005			kg	Other	
		Input	Refined resource	Feldspar	2.586e-006			kg	Other	
		Input	Refined resource	Forest land	112.8			m2 year	Ground	
		Input	Refined resource	Fuel oil	0.233			kg	Other	
		Input	Refined resource	Ground water	1.746e-007			kg	Ground	
		Input	Refined resource	Hard coal	6.559			kg	Ground	
		Input	Refined resource	HCl	0.003243			kg	Technosphere	
		Input	Refined resource	Hydro power	0.003512			kg	Other	
		Input	Refined resource	Hydro power	43.53			MJ	Ground	
		Input	Refined resource	Iron	8.159e-006			kg	Technosphere	
		Input	Refined resource	Iron ore	10.66			kg	Other	
		Input	Refined resource	Lignite	5.174			kg	Ground	
		Input	Refined resource	Lime	0.0004998			kg	Technosphere	
		Input	Refined resource	Lime	4.962e-006			kg	Other	
		Input	Refined resource	Limestone	0.504			kg	Other	
		Input	Refined resource	Manganese	4.566e-008			kg	Technosphere	
		Input	Refined resource	Na2SO4	9.111e-005			kg	Other	

	Input	Refined resource	Natural gas	0.02411			kg	Other	
	Input	Refined resource	Natural gas	0.9393			kg	Ground	
	Input	Refined resource	NO3-N	0.2334			kg	Other	
	Input	Refined resource	Oil	0.001794			kg	Technosphere	
	Input	Refined resource	Oil	0.004497			kg	Other	
	Input	Refined resource	Oil	46.56			MJ	Technosphere	
	Input	Refined resource	Oxygen	0.005849			kg	Technosphere	
	Input	Refined resource	Peat	0.002324			kg	Ground	
	Input	Refined resource	Peat	0.00276			kg	Other	
	Input	Refined resource	Portland soda	4.071e-006			kg	Other	
	Input	Refined resource	Renewable energy source	0.01524			kg	Other	
	Input	Refined resource	Renewable fuel	337.7			MJ	Technosphere	
	Input	Refined resource	Sand	2.853e-005			kg	Other	
	Input	Refined resource	Sodium chloride	1.376e-005			kg	Ground	
	Input	Refined resource	Softwood	0.00322			kg	Ground	
	Input	Refined resource	Solvey soda	4.071e-006			kg	Other	
	Input	Refined resource	Sulphuric acid	0.0008367			kg	Technosphere	
	Input	Refined resource	Unspecified fuel	7.729e-005			MJ	Ground	
	Input	Refined resource	Uranium	4.11e-006			kg	Other	
	Input	Refined resource	Water	0.01039			kg	Other	
	Input	Refined resource	Wind power	0.03887			MJ	Ground	
	Input	Refined resource	Wood	0.00139			kg	Ground	
	Input	Refined resource	Wood chips	48.43			kg	Ground	
	Input	Refined resource	Zn	0.21			kg	Ground	
	Output	Co-product	Steam	0.9578			MJ	Technosphere	
	Output	Co-product	Steel scrap	0.2413			kg	Technosphere	
	Output	Emission	Acid as H+	2.949e-006			kg	Water	
	Output	Emission	Al	5.101e-005			kg	Water	
	Output	Emission	Aldehydes	1.071e-006			kg	Air	
	Output	Emission	Aliphatic HC	0.001117			kg	Air	
	Output	Emission	Aromates (C9-C10)	1.015e-006			kg	Water	
	Output	Emission	Aromates (C9-C10)	3.249e-006			kg	Air	
	Output	Emission	As	1.396e-006			kg	Air	
	Output	Emission	As	4.05e-007			kg	Water	
	Output	Emission	Ashes	2.12			kg	Air	
	Output	Emission	B	0.0001961			kg	Air	
	Output	Emission	Benzene	5.991e-005			kg	Air	
	Output	Emission	Benzo(a)pyrene	1.172e-009			kg	Air	
	Output	Emission	BOD	0.03725			kg	Water	
	Output	Emission	BOD5	6.43e-006			kg	Water	
	Output	Emission	Cd	2.02e-007			kg	Water	
	Output	Emission	Cd	5.064e-007			kg	Air	
	Output	Emission	CH4	0.01276			kg	Air	
	Output	Emission	Chloride	9.925e-007			kg	Water	
	Output	Emission	Cl-	0.1579			kg	Water	

	Output	Emission	CN-	3.407e-007			kg	Water	
	Output	Emission	CN-	6.014e-007			kg	Air	
	Output	Emission	CO	0.4703			kg	Air	
	Output	Emission	Co	1.018e-007			kg	Water	
	Output	Emission	Co	5.161e-007			kg	Air	
	Output	Emission	CO2	33.82			kg	Air	
	Output	Emission	COD	0.07862			kg	Water	
	Output	Emission	Cr	1.248e-006			kg	Water	
	Output	Emission	Cr	1.713e-006			kg	Air	
	Output	Emission	Cr3+	1.199e-006			kg	Air	
	Output	Emission	Cr3+	1.817e-006			kg	Water	
	Output	Emission	Cu	3.756e-006			kg	Air	
	Output	Emission	Cu	8.408e-007			kg	Water	
	Output	Emission	Dioxin	1.453e-011			kg	Air	
	Output	Emission	Dissolved organic carbon	2.533e-014			kg	Water	
	Output	Emission	Dissolved solids	0.004023			kg	Water	
	Output	Emission	Dust	0.04475			kg	Air	
	Output	Emission	F-	3.825e-005			kg	Water	
	Output	Emission	Fe	0.0006746			kg	Air	
	Output	Emission	Fe	0.008029			kg	Water	
	Output	Emission	Fluorides	3.764e-009			kg	Air	
	Output	Emission	Fluorides	5.079e-007			kg	Water	
	Output	Emission	H2S	1.116e-008			kg	Water	
	Output	Emission	H2S	7.161e-007			kg	Air	
	Output	Emission	HC	0.00164			kg	Air	
	Output	Emission	HCl	0.001248			kg	Air	
	Output	Emission	Heavy metals	4.723e-019			kg	Air	
	Output	Emission	HF	0.0002966			kg	Air	
	Output	Emission	Hg	1.091e-006			kg	Air	
	Output	Emission	HNO3	1.376e-007			kg	Water	
	Output	Emission	Hydrocarbons	0.07608			kg	Air	
	Output	Emission	Hydrocarbons	3.564e-006			kg	Water	
	Output	Emission	Iron	3.603e-007			kg	Water	
	Output	Emission	Metals	4.909e-007			kg	Water	
	Output	Emission	Metals	9.819e-008			kg	Air	
	Output	Emission	Methane	0.06551			kg	Air	
	Output	Emission	Mg	5.783e-005			kg	Air	
	Output	Emission	Mn	1.475e-005			kg	Water	
	Output	Emission	Mn	2.105e-006			kg	Air	
	Output	Emission	Mo	2.72e-007			kg	Air	
	Output	Emission	N total	0.00166			kg	Water	
	Output	Emission	N2O	0.0008263			kg	Air	
	Output	Emission	Na+	8.297e-008			kg	Water	
	Output	Emission	NaCl	4.303e-007			kg	Water	
	Output	Emission	NH3	3.076e-007			kg	Water	
	Output	Emission	NH3	6.399e-006			kg	Air	
	Output	Emission	NH4+ as N	5.596e-005			kg	Water	
	Output	Emission	NH4-N	3.454e-005			kg	Water	
	Output	Emission	NH4NO3	1.004e-005			kg	Water	
	Output	Emission	NH4NO3	2.745e-006			kg	Air	
	Output	Emission	Ni	1.995e-006			kg	Water	
	Output	Emission	Ni	2.204e-005			kg	Air	
	Output	Emission	Nitrogen	2.19e-006			kg	Water	
	Output	Emission	NMVOC	0.01162			kg	Air	
	Output	Emission	NMVOC, diesel engines	0.0002949			kg	Air	
	Output	Emission	NMVOC, natural gas combustion	6.183e-005			kg	Air	
	Output	Emission	NMVOC, oil combustion	0.01778			kg	Air	
	Output	Emission	NMVOC, petrol engines	3.621e-014			kg	Air	
	Output	Emission	NMVOC, power plants	0.0001646			kg	Air	
	Output	Emission	NO2-N	2.179e-006			kg	Water	

	Output	Emission	NO3- as N	2.977e-008			kg	Water	
	Output	Emission	NOx	0.2225			kg	Air	
	Output	Emission	N-tot	0.0001609			kg	Water	
	Output	Emission	Oil	0.003383			kg	Water	
	Output	Emission	Oil	2.153e-005			kg	Air	
	Output	Emission	Olivine	1.411e-005			kg	Water	
	Output	Emission	Other organics	0.002652			kg	Water	
	Output	Emission	Other organics	2.433e-007			kg	Air	
	Output	Emission	P total	1.774e-006			kg	Water	
	Output	Emission	PAH	8.066e-007			kg	Air	
	Output	Emission	Particles	0.02506			kg	Air	
	Output	Emission	Particles	3.644e-006			kg	Water	
	Output	Emission	Pb	3.357e-006			kg	Water	
	Output	Emission	Pb	5.264e-006			kg	Air	
	Output	Emission	Phenol	1.146e-007			kg	Air	
	Output	Emission	Phenol	6.513e-007			kg	Water	
	Output	Emission	Phosphorus	0.0003729			kg	Air	
	Output	Emission	PO43-	9.475e-006			kg	Water	
	Output	Emission	P-tot	1.962e-006			kg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	1.381e+006			Bq	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	1.864e+008			Bq	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radon-222	957.5			Bq	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Rn-222	5.511e+005			Bq	Air	
	Output	Emission	Sb	1.22e-009			kg	Water	
	Output	Emission	Sb	2.491e-007			kg	Air	
	Output	Emission	Se	2.977e-006			kg	Air	
	Output	Emission	Sn	4.48e-008			kg	Air	
	Output	Emission	Sn	9.562e-005			kg	Water	
	Output	Emission	SO2	0.2316			kg	Air	
	Output	Emission	SO4 2-	0.001407			kg	Water	
	Output	Emission	SO42-	0.05615			kg	Water	
	Output	Emission	Sodium chloride	0.01789			kg	Water	
	Output	Emission	SOx	0.001632			kg	Air	
	Output	Emission	Sr	2.018e-006			kg	Air	
	Output	Emission	Sr	4.729e-005			kg	Water	
	Output	Emission	Susp solids	4.575e-005			kg	Water	
	Output	Emission	Suspended solids	0.01608			kg	Water	
	Output	Emission	Th	3.206e-008			kg	Air	
	Output	Emission	Tl	5.525e-009			kg	Air	
	Output	Emission	Tot-CN	1.314e-006			kg	Water	
	Output	Emission	U	3.077e-008			kg	Air	
	Output	Emission	V	2.858e-007			kg	Water	
	Output	Emission	V	5.262e-005			kg	Air	
	Output	Emission	VOC	0.03573			kg	Air	
	Output	Emission	VOC, coal combustion	4.852e-006			kg	Air	
	Output	Emission	VOC, diesel engines	0.0001341			kg	Air	
	Output	Emission	VOC, natural gas combustion	3.779e-013			kg	Air	
	Output	Emission	Zn	1.937e-005			kg	Water	
	Output	Emission	Zn	2.191e-005			kg	Air	
	Output	Product	plywood box	52.61			kg	Technosphere	

	Output	Residue	Ashes	0.0004614			kg	Technosphere	
	Output	Residue	Bulky	2.018			kg	Technosphere	
	Output	Residue	Chemicals	1.546e-005			kg	Technosphere	
	Output	Residue	Demolition	0.0003495			kg	Technosphere	
	Output	Residue	Hazardous	0.3879			kg	Technosphere	
	Output	Residue	Hazardous waste	0.1576			kg	Technosphere	
	Output	Residue	Highly active rad ac waste	2.761e-011			kg	Ground	
	Output	Residue	Highly radioactive	0.0002329			kg	Technosphere	
	Output	Residue	Highly radioactive	0.0149			cm3	Ground	
	Output	Residue	Highly radioactive	9.455e-010			kg	Ground	
	Output	Residue	Industrial	2.847			kg	Technosphere	
	Output	Residue	Low radioactive	0.1699			cm3	Ground	
	Output	Residue	Medium radioactive	0.1699			cm3	Ground	
	Output	Residue	Medium radioactive	5.156e-009			kg	Ground	
	Output	Residue	Mineral	0.0002004			kg	Technosphere	
	Output	Residue	Mining waste	0.07451			kg	Technosphere	
	Output	Residue	Other	0.552			kg	Technosphere	
	Output	Residue	Other rest products	0.366			kg	Technosphere	
	Output	Residue	Radioactive	0.00139			kg	Technosphere	
	Output	Residue	Radioactive waste	0.0001927			kg	Ground	
	Output	Residue	Rubber	2.347e-006			kg	Technosphere	
	Output	Residue	Scrap	0.02811			kg	Technosphere	
	Output	Residue	Slags & ashes	0.01089			kg	Technosphere	
	Output	Residue	Slags & ashes (energy production)	0.4652			kg	Technosphere	
	Output	Residue	Slags & ashes (waste incineration)	3.006e-008			kg	Technosphere	
	Output	Residue	Sludge	0.0005239			kg	Technosphere	
	Output	Residue	Solid	0.5641			kg	Technosphere	
	Output	Residue	Steel	0.8125			kg	Technosphere	
	Output	Residue	Waste	4.962			kg	Technosphere	
	Output	Residue	Wood	4.129			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. Both types of bearings are packed in a plywood box. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The dataset is applicable to plywood boxes of this dimension manufactured by Nefab Emballage AB in Alfta, Sweden. Care must be taken since transportation is included in the dataset. Raw material must thus come from the same suppliers or suppliers in the same area.
About Data	The data is gathered from interviews with Kjell-Arne Jonsson at Nefab Emballage AB in Alfta. Much of the data is taken from earlier LCA studies. See under the subactivities for more detailed information. Distances and type of transportations are taken from:

	* Hillvall Maria; Transportförpackningars bidrag till reduktion av miljöbelastningen; Master Thesis at the Technical University of Luleå; 2000. * Weström Pär, Packforsk Consulting AB; Simplified life cycle assessment for the comparison of two packaging alternatives for medium-sized roller bearings; Report no. C00 528; April 2001.
Notes	

SPINE LCI dataset: Production of polyamid 66 containing 30% glass fibre (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of polyamid 66 containing 30% glass fibre (APME)
Functional Unit	1 kg of polyamid 66 containing 30% glass fibre.
Functional Unit Explanation	The polyamids (PA´s) are a group of polymers characterised by a carbon chain with -CO-NH- groups interspersed at regular intervals along it. They are commonly referred to by the generic name nylon and may be produced by the direct polymerisation of amino-acids or by the reaction of a diamine with a dibasic acid. Typical uses of polyamids: - radiator end tanks - air intake manifolds - covers of various types.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Production of polyamid 66 include all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. Nylon (PA66) may be produced by the direct polymerisation of amino-acids or by the reaction of a diamine with a dibasic acid. The essential precursors for nylon 66 are hexamethylene diamine, and adipic acid. When they are reacted they produce hexamethylene diammonium adipate, commonly referred to as nylon salt. For fibre applications, it is important to ensure that the precursors are reacted in equimolar proportions and that the product is highly purified. The formation, extraction and purification of the salt ensures that these conditions are met. Adipic acid is made by the oxidation of cyclohexane to a mixture of cyclohexanol and cyclohexanone (called KA oil). This mixture is further oxidised with nitric acid to adipic acid. Hexamethylene diamine is made by the reduction of adiponitrile, which is made either by the electronic coupling of acrylonitrile or by the hydrocyanation of butadiene. Adipic acid and hexamethylene diamine are combined in water to make a salt solution. This solution is then passed through a batch or continous reactor in which the water is removed at high temperature and the nylon polymerises. The polymer is expelled from the reactor and granulated. Higher molecular weights are compounding of the the nylon with the modifiers or reinforcements. In some cases, it is possible to compound directly at the reactor without granulating the nylon. The results here refer to nylon66 containing 30% glass fibre. Operating conditions: As the data are based on information from 3 plants in 2 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity

	production efficiency. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries	
Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 3 polyamide producers in Germany and France. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 3 polyamid production plants in 2 countries: France and Germany. Their total production was 13 000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or

	chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, mixed
Represents	
Method	European average data. Results are based on data supplied by 3 polyamid production plants in 2 countries: France and Germany. Their total production was 13 000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports/htm/alphabetical.htm www.lca.apme.org
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	1327184.054			mg	Air	Europe
	Input	Natural resource	B	273.6934664238765			mg	Ground	World
	Input	Natural resource	Barytes	7.612345106			mg	Ground	Europe
	Input	Natural resource	Bauxite	269.7864809			mg	Ground	Europe
	Input	Natural resource	Bentonite	78.42987843			mg	Ground	Europe
	Input	Natural resource	Biomass	3044.42773			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	7.737417595			mg	Ground	Europe
	Input	Natural resource	Chalk	1.25E-22			mg	Ground	Europe
	Input	Natural resource	Clay	9.84111262			mg	Ground	Europe
	Input	Natural resource	Cr	0.281285025			mg	Ground	Europe

	Input	Natural resource	Crude oil	21.90462921			mg	Ground	Europe
	Input	Natural resource	Crude oil	562697.9623			mg	Ground	Europe
	Input	Natural resource	Dolomite	67218.17506			mg	Ground	Europe
	Input	Natural resource	Fe	1547.206794			mg	Ground	Europe
	Input	Natural resource	Feldspar	1.85E-28			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	1.352002325			mg	Ground	Europe
	Input	Natural resource	Fluorite	4.351201342			mg	Ground	Europe
	Input	Natural resource	Granite	8.19E-02			mg	Ground	Europe
	Input	Natural resource	Gravel	5.487545494			mg	Ground	Europe
	Input	Natural resource	Hard coal	543235.502			mg	Ground	Europe
	Input	Natural resource	Hydro energy	0.492265309			MJ	Ground	Europe
	Input	Natural resource	Lignite	146541.7143			mg	Ground	Europe
	Input	Natural resource	Limestone	158097.4006			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	594.9738752			mg	Ground	Europe
	Input	Natural resource	Mg	1.178226054			mg	Ground	Europe
	Input	Natural resource	Natural gas	1134997.199			mg	Ground	Europe
	Input	Natural resource	Ni	4.53E-02			mg	Ground	Europe
	Input	Natural resource	Nitrogen	315807.1458			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	7.087480163			MJ	Ground	Europe
	Input	Natural resource	Olivine	13.8233489			mg	Ground	Europe
	Input	Natural resource	Oxygen	64495.94286			mg	Ground	Europe
	Input	Natural resource	Pb	9.571493747			mg	Ground	Europe
	Input	Natural resource	Peat	119.1909718			mg	Ground	Europe
	Input	Natural resource	Phosphate	288.6058982			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	1416.613596			mg	Ground	Europe
	Input	Natural resource	Rutile	1.79E-22			mg	Ground	Europe
	Input	Natural resource	Sand	193438.3505			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	192546.7331			mg	Ground	Europe
	Input	Natural resource	Sulphur	84623.72356			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	5124.985696			mg	Ground	Europe
	Input	Natural resource	Talc	0			mg	Ground	Europe
	Input	Natural resource	Ulexite (B5H3O9.Ca.8H20.Na)	19200.006			mg	Ground	World
	Input	Natural resource	Water	336768437.6			mg	Water	Europe
	Input	Natural resource	Wood	14012.47809			mg	Ground	Europe
	Input	Natural resource	Zn	17.07346837			mg	Ground	Europe
	Output	By-product	Recovered energy	3.869950299			MJ	Technosphere	Europe
	Output	By-product	To incinerator	782.1607756			mg	Technosphere	Europe
	Output	By-product	To recycling	12511.1049			mg	Technosphere	Europe

	Output	Emission	1,2-Dichloroethane	1.61E-09			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	8.03E-07			mg	Air	Europe
	Output	Emission	Acid as H+	48.62823106			mg	Water	Europe
	Output	Emission	Al	4.555922308			mg	Water	Europe
	Output	Emission	Aldehydes	22.86414387			mg	Air	Europe
	Output	Emission	As	3.56E-03			mg	Water	Europe
	Output	Emission	B	446.0004458904208			mg	Water	Europe
	Output	Emission	BOD5	394.7099084			mg	Water	Europe
	Output	Emission	Ca2+	9.309360589			mg	Water	Europe
	Output	Emission	CH4	21975.06716			mg	Air	Europe
	Output	Emission	Chloroorganics	0.151965958			mg	Air	Europe
	Output	Emission	Chloroorganics	1.258372257			mg	Water	Europe
	Output	Emission	Cl-	5423.46082			mg	Water	Europe
	Output	Emission	Cl2	0.241519524			mg	Water	Europe
	Output	Emission	Cl2	2.43E-02			mg	Air	Europe
	Output	Emission	CN-	1.17E-02			mg	Water	Europe
	Output	Emission	CO	5968.446417			mg	Air	Europe
	Output	Emission	CO2	5442066.004			mg	Air	Europe
	Output	Emission	CO32-	83.8224756			mg	Water	Europe
	Output	Emission	COD	4480.725517			mg	Water	Europe
	Output	Emission	CrO3	2.43E-04			mg	Water	Europe
	Output	Emission	CS2	1.52E-04			mg	Air	Europe
	Output	Emission	Cu	6.067999201			mg	Water	Europe
	Output	Emission	Dissolved organics	198.180953			mg	Water	Europe
	Output	Emission	Dissolved solids	3008.233133			mg	Water	Europe
	Output	Emission	F-	1.06E-02			mg	Water	Europe
	Output	Emission	F2	2.240913103			mg	Air	Europe
	Output	Emission	Fe	4.61355001			mg	Water	Europe
	Output	Emission	H2	1413.318434			mg	Air	Europe
	Output	Emission	H2S	1.457787839			mg	Air	Europe
	Output	Emission	H2SO4	3.12E-05			mg	Air	Europe
	Output	Emission	Halogenated hydrocarbons (chlorofluoroca	0.212817659			mg	Air	Europe
	Output	Emission	HCl	208.7629139			mg	Air	Europe
	Output	Emission	HCN	1.590350887			mg	Air	Europe
	Output	Emission	HF	10.24867215			mg	Air	Europe
	Output	Emission	Hg	0.11682643			mg	Air	Europe
	Output	Emission	Hg	3.89E-03			mg	Water	Europe
	Output	Emission	K+	43.59523296			mg	Water	Europe
	Output	Emission	Metals	243.0609997			mg	Water	Europe
	Output	Emission	Metals	7.704145185			mg	Air	Europe
	Output	Emission	Mg	0.428422878			mg	Water	Europe
	Output	Emission	N total	514.4121729			mg	Water	Europe
	Output	Emission	N2O	2233.622214			mg	Air	Europe
	Output	Emission	Na	9150.974921			mg	Water	Europe
	Output	Emission	NH3	97.75225078			mg	Air	Europe
	Output	Emission	NH4+	806.3384621			mg	Water	Europe
	Output	Emission	Ni	6.064141538			mg	Water	Europe
	Output	Emission	NO3-	7286.965466			mg	Water	Europe
	Output	Emission	NOx	29443.06359			mg	Air	Europe
	Output	Emission	Oil	41.27034018			mg	Water	Europe
	Output	Emission	P2O5	177.1831709			mg	Water	Europe
	Output	Emission	PAH	9.99E-29			mg	Air	Europe
	Output	Emission	Particles	8606.349484			mg	Air	Europe
	Output	Emission	Pb	1.48E-03			mg	Water	Europe
	Output	Emission	Pb	5.02E-04			mg	Air	Europe
	Output	Emission	Phenol	8.061642722			mg	Water	Europe
	Output	Emission	S2-	0.604938019			mg	Water	Europe
	Output	Emission	SO2	21927.40739			mg	Air	Europe
	Output	Emission	SO42-	16394.8011			mg	Water	Europe
	Output	Emission	Suspended solids	16775.05924			mg	Water	Europe
	Output	Emission	Thiols	6.09E-02			mg	Air	Europe
	Output	Emission	Vinyl chloride	2.33E-25			mg	Water	Europe
	Output	Emission	Vinyl chloride	5.36E-07			mg	Air	Europe
	Output	Emission	VOC	20.0856308			mg	Water	Europe

	Output	Emission	VOC	271.4184584			mg	Air	Europe
	Output	Emission	VOC	36.41018385			mg	Water	Europe
	Output	Emission	VOC	5404.600246			mg	Air	Europe
	Output	Emission	VOC	56.41163096			mg	Air	Europe
	Output	Emission	Zn	4.31E-03			mg	Water	Europe
	Output	Product	PA 66 + 30%GF	1			kg	Technosphere	Europe
	Output	Residue	Construction	13.34147715			mg	Ground	Europe
	Output	Residue	Industrial	13135.88313			mg	Ground	Europe
	Output	Residue	Inert chemical	1620.159501			mg	Ground	Europe
	Output	Residue	Metals	162.1224889			mg	Ground	Europe
	Output	Residue	Mineral	229299.2163			mg	Ground	Europe
	Output	Residue	Paper & board	813.0991092			mg	Ground	Europe
	Output	Residue	Plastics	71.25739901			mg	Ground	Europe
	Output	Residue	Regulated chemical	14564.30986			mg	Ground	Europe
	Output	Residue	Slags & ashes	30377.91092			mg	Ground	Europe
	Output	Residue	Unspecified	2472.575535			mg	Ground	Europe
	Output	Residue	Wood waste	94.18537652			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PA66+30%GF. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. --- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 ---
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .
Reviewer	-
Applicability	European average data. Results are based on data supplied by 3 polyamid production plants in 2 countries: France and Germany. Their total production was 13 000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful.

	It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for polyamid 66 with 30% glass fibre - production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of PA66+30%GF in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Note that emissions <0,5 mg (0,25 mg in data table) may be far below 0,5 mg in some cases. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe

	Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

SPINE LCI dataset: Production of polybutadiene (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of polybutadiene (APME)
Functional Unit	1 kg polybutadiene
Functional Unit Explanation	Typical uses for polybutadiene are production of ABS (Acrylonitrile-butadiene-styren copolymer) and synthetic rubbers.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. All flows have been followed to the cradle. However, only the main production process is been described here. Polybutadiene is produced by free radical polymerisation of butadiene; indeed one of the problems in storing butadiene is to prevent polymerisation. Polymerisation is usually carried out in suspension or emulsion. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries	
Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names

	elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the years 1992-1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 4 polybutadiene producers in Germany and Italy. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 4 polybutadiene production plants in 2 countries: Germany and Italy. Their total production was 88,000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1992-1995
Data Type	Derived, mixed
Represents	

Method	European average data. Results are based on data supplied by 4 polybutadiene production plants in 2 countries: Germany and Italy. Their total production was 88,000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	300796.211			mg	Ground	Europe
	Input	Natural resource	Barytes	0.364654563			mg	Ground	Europe
	Input	Natural resource	Bauxite	428.2363966			mg	Ground	Europe
	Input	Natural resource	Bentonite	142.5494139			mg	Ground	Europe
	Input	Natural resource	Biomass	727.7002388			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	14.21018335			mg	Ground	Europe
	Input	Natural resource	Chalk	7.35E-21			mg	Ground	Europe
	Input	Natural resource	Chromium	6.90E-04			mg	Ground	Europe
	Input	Natural resource	Clay	18.65340672			mg	Ground	Europe
	Input	Natural resource	Crude oil	1285391.917			mg	Ground	Europe
	Input	Natural resource	Dolomite	7.539143615			mg	Ground	Europe
	Input	Natural resource	Feldspar	1.10E-26			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	0.547717052			mg	Ground	Europe
	Input	Natural resource	Fluorite	2.117736949			mg	Ground	Europe
	Input	Natural resource	Granite	2.04E-04			mg	Ground	Europe
	Input	Natural resource	Gravel	2.224883097			mg	Ground	Europe
	Input	Natural resource	Hard coal	296494.3775			mg	Ground	Europe
	Input	Natural resource	Hydro energy	6.95E-02			MJ	Ground	Europe
	Input	Natural resource	Hydrogen	3.46E-03			MJ	Ground	Europe
	Input	Natural resource	Iron in ore	694.3796227			mg	Ground	Europe

	Input	Natural resource	Lead in ore	1.080393455			mg	Ground	Europe
	Input	Natural resource	Lignite	15805.07671			mg	Ground	Europe
	Input	Natural resource	Limestone	175313.5183			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	249.8499002			mg	Ground	Europe
	Input	Natural resource	Natural gas	786280.0093			mg	Ground	Europe
	Input	Natural resource	Nickel	1.55E-04			mg	Ground	Europe
	Input	Natural resource	Nitrogen	1448289.953			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	1.375742399			MJ	Ground	Europe
	Input	Natural resource	Olivine	5.657326577			mg	Ground	Europe
	Input	Natural resource	Oxygen	19.22552072			mg	Ground	Europe
	Input	Natural resource	Peat	1.148958798			mg	Ground	Europe
	Input	Natural resource	Phosphate	5.69E-03			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	20.19659878			mg	Ground	Europe
	Input	Natural resource	Sand	560.82247			mg	Ground	Europe
	Input	Natural resource	Shale oils	40.22902906			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	2511.216965			mg	Ground	Europe
	Input	Natural resource	Sulphur	355.3080227			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	148.3054359			mg	Ground	Europe
	Input	Natural resource	Unspecified fuel	0.393455242			MJ	Ground	Europe
	Input	Natural resource	Water, cooling	79002035.37			mg	Water	Europe
	Input	Natural resource	Water, process	7794920			mg	Water	Europe
	Input	Natural resource	Wood	2.13530291			mg	Ground	Europe
	Input	Natural resource	Zinc in ore	4.06E-02			mg	Ground	Europe
	Output	Co-product	Recovered energy	1.839637501			MJ	Ground	Europe
	Output	Emission	1,2-Dichloroethane	6.70E-12			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	9.29E-08			mg	Air	Europe
	Output	Emission	Acid as H+	43.01963583			mg	Water	Europe
	Output	Emission	Al3+	1.897004694			mg	Water	Europe
	Output	Emission	Aldehydes	1.62E-04			mg	Air	Europe
	Output	Emission	Aromatic VOC	16.97181227			mg	Air	Europe
	Output	Emission	As	1.10E-03			mg	Water	Europe
	Output	Emission	BOD	47.14023132			mg	Water	Europe
	Output	Emission	Ca2+	0.123514856			mg	Water	Europe
	Output	Emission	CFCs	3.51E-02			mg	Air	Europe
	Output	Emission	Chloroorganics	4.27E-03			mg	Water	Europe
	Output	Emission	Chloroorganics	9.19E-03			mg	Air	Europe
	Output	Emission	Cl-	1088.48941			mg	Water	Europe
	Output	Emission	Cl2	5.18E-03			mg	Water	Europe
	Output	Emission	Cl2	5.60E-04			mg	Air	Europe
	Output	Emission	CN-	2.13E-03			mg	Water	Europe
	Output	Emission	CO	2563.24542			mg	Air	Europe
	Output	Emission	CO2	3310101.106			mg	Air	Europe
	Output	Emission	CO32-	151.8037099			mg	Water	Europe
	Output	Emission	COD	343.0667262			mg	Water	Europe
	Output	Emission	CrO3	8.31E-04			mg	Water	Europe
	Output	Emission	CS2	6.83E-04			mg	Air	Europe
	Output	Emission	Cu	2.54E-02			mg	Water	Europe

	Output	Emission	Detergents	236.9159501			mg	Water	Europe
	Output	Emission	Dissolved organics	89.61516996			mg	Water	Europe
	Output	Emission	Dissolved solids	485.7789999			mg	Water	Europe
	Output	Emission	Dust	2975.043955			mg	Air	Europe
	Output	Emission	F-	2.12E-03			mg	Water	Europe
	Output	Emission	F2	5.27E-05			mg	Air	Europe
	Output	Emission	Fe	2.85E-02			mg	Water	Europe
	Output	Emission	H2	4.161211561			mg	Air	Europe
	Output	Emission	H2S	2.09E-02			mg	Air	Europe
	Output	Emission	H2SO4	5.39E-08			mg	Air	Europe
	Output	Emission	HCl	63.72144647			mg	Air	Europe
	Output	Emission	HCN	3.60E-26			mg	Air	Europe
	Output	Emission	HF	3.295821895			mg	Air	Europe
	Output	Emission	Hg	7.82E-05			mg	Water	Europe
	Output	Emission	Hg	9.40E-04			mg	Air	Europe
	Output	Emission	Hydrocarbons	10806.19508			mg	Air	Europe
	Output	Emission	Hydrocarbons	73.57413161			mg	Water	Europe
	Output	Emission	K+	0.595206885			mg	Water	Europe
	Output	Emission	Metals	4.019641097			mg	Air	Europe
	Output	Emission	Metals	48.38819799			mg	Water	Europe
	Output	Emission	Methane	11184.68657			mg	Air	Europe
	Output	Emission	Mg2+	4.97E-03			mg	Water	Europe
	Output	Emission	N2O	0.248990119			mg	Air	Europe
	Output	Emission	Na+	491.8124508			mg	Water	Europe
	Output	Emission	NH3	7.52E-02			mg	Air	Europe
	Output	Emission	NH4+	2.119248723			mg	Water	Europe
	Output	Emission	Ni2+	1.57E-03			mg	Water	Europe
	Output	Emission	NO3-	5.798174731			mg	Water	Europe
	Output	Emission	Other nitrogen	2.915811807			mg	Water	Europe
	Output	Emission	Other organics	11.82639351			mg	Water	Europe
	Output	Emission	Other organics	51.89209962			mg	Air	Europe
	Output	Emission	P2O5	8.74E-02			mg	Water	Europe
	Output	Emission	PAH	5.89E-27			mg	Air	Europe
	Output	Emission	Pb	1.03E-03			mg	Water	Europe
	Output	Emission	Pb	3.62E-04			mg	Air	Europe
	Output	Emission	Phenol	7.972102825			mg	Water	Europe
	Output	Emission	SO42-	388.1876397			mg	Water	Europe
	Output	Emission	Sulphur	5.24E-03			mg	Water	Europe
	Output	Emission	Suspended solids	802.3015069			mg	Water	Europe
	Output	Emission	Thiols	0.202433163			mg	Air	Europe
	Output	Emission	Vinyl chloride	1.37E-23			mg	Water	Europe
	Output	Emission	Vinyl chloride	1.42E-09			mg	Air	Europe
	Output	Emission	Zn2+	1.73E-02			mg	Water	Europe
	Output	Product	Polybutadiene	1			kg	Technosphere	Europe
	Output	Residue	Construction	3.52E-02			mg	Ground	Europe
	Output	Residue	Industrial waste	6400.005446			mg	Ground	Europe
	Output	Residue	Inert chemical	263.4684581			mg	Ground	Europe
	Output	Residue	Metals	8.045765599			mg	Ground	Europe
	Output	Residue	Mineral	60702.2629			mg	Ground	Europe
	Output	Residue	Plastics	0.418123802			mg	Technosphere	Europe
	Output	Residue	Regulated chemical	599.3347513			mg	Ground	Europe
	Output	Residue	Slags & ashes (energy production)	9180.532088			mg	Ground	Europe
	Output	Residue	To incinerator	412.6939378			mg	Technosphere	Europe
	Output	Residue	To recycling	182.0794022			mg	Technosphere	Europe
	Output	Residue	Unspecified	82.83862261			mg	Ground	Europe
	Output	Residue	Wood waste	2.12E-02			mg	Technosphere	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for polybutadiene. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. --

	Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 3 April 2002 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	
Practitioner	Boustead, Ian - .
Reviewer	Not available -
Applicability	European average data. Results are based on data supplied by 4 polybutadiene production plants in 2 countries: Germany and Italy. Their total production was 88,000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for polybutadiene production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of polybutadiene in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant).

	Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

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SPINE LCI dataset: Production of polyethylene resin (HDPE), (APME)

Administrative	
Finished	Y
Date Completed	1999

Copyright	APME
Availability	Public

Technical System

Name	Production of polyethylene resin (HDPE), (APME)
Functional Unit	1 kg of high density polyethylene resin (HDPE)
Functional Unit Explanation	High density Polyethylene resin (HDPE) can be used to make various items. The structure of the molecule is the simplest of the polymers used in commercial production. Typical uses for high density polyethylene resin are: food containers, automobile fuel tanks, bottles, pipes and film.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. The polyolefins (polyethylene and polypropene) are chemically the simplest of the polymers in commercial production. They are usually polymerised by a free radical mechanism whereby an initiator opens the double bond of the alkene molecule and attaches itself leaving the other ''open'' bond, or radical free to attac a further alkene molecule. The process repeats itself until all of the monomer is used up or, more commonly, the reactive end is itself terminated by specifically added reactants. Depending on how the polymerisation reaction is carried out, the polymer chains may be highly linear or they may be side branched. The length and frequency of the side chains plays an important part in determining the ultimate properties of the polymer. Linear chains, chains with fex side branches and chains with very short side branches, allow the polymer to pack in a regular structure in the solid state, producing a high density, crystalline structure with superior mechanical properties. In practice it is impossible to produce completely unbranched polymer molecules on a commercial scale but, by regulating the length and frequency of the side branches, it is possible to produce a variety of different polymer grades with different processing characteristics and in-services properties. The polyethylenes available commercially can be divided into three main groups: low density polyethylene, high-density polyethylene and linear low-density polyethylene. Low-density polyethylene is produced in a high pressure process and contains a high level of side branching with relatively long side chains. High-density polyethylene is produced in a low pressure process and contains fewer side branches. Linear low-density polyethylene contains a large number of side branches but they are very short so that the polymer is able to pack well in the solid state. The chemical structure of the polymer is a repeated series of -CH2-CH2-. Operating conditions: As the data are based on information from 10 plants in 7 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the

	emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1992-1993. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 10 HDPE producers in Austria, Belgium, France, Netherlands, Portugal, Sweden and UK. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 10 HDPE production plants in 7 countries: Austria, Belgium, France, Netherlands, Portugal, Sweden and UK. Their total production was 4 065 000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1992-1993
Data Type	Derived, mixed
Represents	

Method	European average data. Results are based on data supplied by 10 polyethylene production plants in 7 countries: Austria, Belgium, France, Netherlands, Portugal, Sweden and UK. Their total production was 4 065 000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports /htm/alphabetical.htm
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	119335.4667			mg	Air	Europe
	Input	Natural resource	Barytes	9.38E-02			mg	Ground	Europe
	Input	Natural resource	Bauxite	35998.03389			mg	Ground	Europe
	Input	Natural resource	Bentonite	25.04961535			mg	Ground	Europe
	Input	Natural resource	Biomass	3429.174736			mg	Ground	Europe
	Input	Natural resource	Calcium fluoride	644.8194674			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	2.495358497			mg	Ground	Europe
	Input	Natural resource	Chalk	3.18E-22			mg	Ground	Europe
	Input	Natural resource	Clay	10.86345508			mg	Ground	Europe
	Input	Natural resource	Cr	2.99E-05			mg	Ground	Europe
	Input	Natural resource	Crude oil	1100592.936			mg	Ground	Europe
	Input	Natural resource	Dolomite	1.599800829			mg	Ground	Europe
	Input	Natural resource	Fe	183.6066365			mg	Ground	Europe
	Input	Natural resource	Feldspar	4.79E-28			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	0.117515142			mg	Ground	Europe
	Input	Natural resource	Granite	615.9004802			mg	Ground	Europe
	Input	Natural resource	Gravel	0.47735861			mg	Ground	Europe
	Input	Natural resource	Hard coal	87785.43241			mg	Ground	Europe
	Input	Natural resource	Hydro energy	1.002496987			MJ	Ground	Europe
	Input	Natural resource	Lignite	6833.252187			mg	Ground	Europe
	Input	Natural resource	Limestone	963.1410103			mg	Ground	Europe
	Input	Natural resource	Magnesium	0			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	52.44330769			mg	Ground	Europe
	Input	Natural resource	Natural gas	449016.7051			mg	Ground	Europe
	Input	Natural resource	Nickel in ore	7.46E-06			mg	Ground	Europe
	Input	Natural resource	Nitrogen	65431.07785			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	3.331637032			MJ	Ground	Europe
	Input	Natural resource	Olivine	1.213804695			mg	Ground	Europe
	Input	Natural resource	Oxygen	39.44397196			mg	Ground	Europe
	Input	Natural resource	Pb	0.363447978			mg	Ground	Europe
	Input	Natural resource	Peat	267.7526852			mg	Ground	Europe
	Input	Natural resource	Phosphate	0.389457292			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	1.030283227			mg	Ground	Europe
	Input	Natural resource	Rutile	4.57E-22			mg	Ground	Europe
	Input	Natural resource	Sand	151.3142684			mg	Ground	Europe

	Input	Natural resource	Shale oils	7.064359904			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	33189.41257			mg	Ground	Europe
	Input	Natural resource	Sulphur	158.4605505			mg	Ground	Europe
	Input	Natural resource	Sulphur in ore	327.0265592			mg	Ground	Europe
	Input	Natural resource	Talc	0			mg	Ground	Europe
	Input	Natural resource	Water	55287241.42			mg	Water	Europe
	Input	Natural resource	Wood	3.019466257			mg	Ground	Europe
	Input	Natural resource	Zinc in ore	1.37E-02			mg	Ground	Europe
	Output	Emission	S2-	4.56302981			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	0			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	1.41E-07			mg	Air	Europe
	Output	Emission	Acid as H+	46.98905217			mg	Water	Europe
	Output	Emission	Al3+	0.193503623			mg	Water	Europe
	Output	Emission	Aldehydes	3.46E-03			mg	Air	Europe
	Output	Emission	As	6.63E-05			mg	Water	Europe
	Output	Emission	BOD	151.9142078			mg	Water	Europe
	Output	Emission	Ca2+	21.34132893			mg	Water	Europe
	Output	Emission	CFCs	5.01E-02			mg	Air	Europe
	Output	Emission	Chloroorganics	2.04E-04			mg	Water	Europe
	Output	Emission	Chloroorganics	8.39E-02			mg	Air	Europe
	Output	Emission	Cl-	343.330602			mg	Water	Europe
	Output	Emission	Cl2	0.482931888			mg	Air	Europe
	Output	Emission	Cl2	3.65E-04			mg	Water	Europe
	Output	Emission	CN-	0.195089865			mg	Water	Europe
	Output	Emission	CO	821.163078			mg	Air	Europe
	Output	Emission	CO2	1747505.227			mg	Air	Europe
	Output	Emission	CO32-	25.49876593			mg	Water	Europe
	Output	Emission	COD	201.0397184			mg	Water	Europe
	Output	Emission	CrO3	3.60E-05			mg	Water	Europe
	Output	Emission	CS2	6.85E-05			mg	Air	Europe
	Output	Emission	Cu	7.46E-02			mg	Water	Europe
	Output	Emission	Dissolved organics	27.3996398			mg	Water	Europe
	Output	Emission	Dissolved solids	348.1983792			mg	Water	Europe
	Output	Emission	F-	18.33030754			mg	Water	Europe
	Output	Emission	F2	0.505405053			mg	Air	Europe
	Output	Emission	Fe	2.711424889			mg	Water	Europe
	Output	Emission	H2	99.77835116			mg	Air	Europe
	Output	Emission	H2S	1.889584863			mg	Air	Europe
	Output	Emission	H2SO4	1.32E-06			mg	Air	Europe
	Output	Emission	HCl	47.76414984			mg	Air	Europe
	Output	Emission	HCN	1.56E-27			mg	Air	Europe
	Output	Emission	HF	2.320105291			mg	Air	Europe
	Output	Emission	Hg	0.248013936			mg	Water	Europe
	Output	Emission	Hg	0.343681558			mg	Air	Europe
	Output	Emission	K+	3.05E-02			mg	Water	Europe
	Output	Emission	Metals	48.01268856			mg	Water	Europe
	Output	Emission	Metals	8.146227934			mg	Air	Europe
	Output	Emission	Methane	5697.084205			mg	Air	Europe
	Output	Emission	Mg2+	2.966871505			mg	Water	Europe
	Output	Emission	N total	7.561616099			mg	Water	Europe
	Output	Emission	Na+	372.6350432			mg	Water	Europe
	Output	Emission	NH3	1.73E-03			mg	Air	Europe
	Output	Emission	NH4+	10.68010504			mg	Water	Europe
	Output	Emission	Ni	7.31E-02			mg	Water	Europe
	Output	Emission	NO2	0.45692294			mg	Air	Europe
	Output	Emission	NO3-	6.317860806			mg	Water	Europe
	Output	Emission	NOx	9899.716609			mg	Air	Europe
	Output	Emission	Oil	67.90317623			mg	Water	Europe
	Output	Emission	Other organics	1.599059976			mg	Water	Europe
	Output	Emission	P2O5	1.05232318			mg	Water	Europe
	Output	Emission	PAH	2.55E-28			mg	Air	Europe
	Output	Emission	Particles	2887.755589			mg	Air	Europe
	Output	Emission	Pb	1.04E-02			mg	Water	Europe
	Output	Emission	Pb	4.36E-05			mg	Air	Europe
	Output	Emission	Phenol	3.84191776			mg	Water	Europe

	Output	Emission	SO2	13690.40205			mg	Air	Europe
	Output	Emission	SO42-	48.66617572			mg	Water	Europe
	Output	Emission	Suspended solids	2062.445582			mg	Water	Europe
	Output	Emission	Thiols	1.97E-02			mg	Air	Europe
	Output	Emission	Vinyl chloride	5.96E-25			mg	Water	Europe
	Output	Emission	Vinyl chloride	9.19E-08			mg	Air	Europe
	Output	Emission	VOC	50.75383537			mg	Water	Europe
	Output	Emission	VOC	6070.114			mg	Air	Europe
	Output	Emission	Zn2+	8.82E-02			mg	Water	Europe
	Output	Product	HDPE	1			kg	Technosphere	
	Output	Residue	Construction	280.0778591			mg	Ground	Europe
	Output	Residue	Industrial	2906.23184			mg	Ground	Europe
	Output	Residue	Inert chemicals	535.8948642			mg	Ground	Europe
	Output	Residue	Metals	11.92858938			mg	Ground	Europe
	Output	Residue	Mineral	73639.84391			mg	Ground	Europe
	Output	Residue	Paper	1.62E-21			mg	Ground	Europe
	Output	Residue	Plastics	10.58786747			mg	Ground	Europe
	Output	Residue	Recovered energy	0.635032814			MJ	Technosphere	Europe
	Output	Residue	Regulated chemicals	7775.139399			mg	Ground	Europe
	Output	Residue	Slags & ashes	5838.541492			mg	Ground	Europe
	Output	Residue	To incinerator	29.19381349			mg	Technosphere	Europe
	Output	Residue	To recycling	11.0879233			mg	Technosphere	Europe
	Output	Residue	Unspecified	1175.738364			mg	Ground	Europe
	Output	Residue	Wood waste	3.02E-02			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for Polyethylene resin (HDPE). ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. --- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 27 November 2001 ---
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Ian Boustead - .
Reviewer	

Applicability	European average data. Results are based on data supplied by 10 production plants in 7 countries: the UK, Austria, Belgium, France, Netherlands, Portugal and Sweden. Their total production was 1,320,000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for polyethylene resin (HDPE) production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of polyethylene resin (HDPE) in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name

	Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

SPINE LCI dataset: Production of polyethylene terephthalate (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of polyethylene terephthalate (APME)
Functional Unit	1 kg of PET
Functional Unit Explanation	PET, Polyethylene terephthalate, is used mainly for polyester fibres. The output of the system is beads of amorphous PET (polyethylene terephtalate) that can be used for fiber spinning, and general purposes.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Production of polyethylene terephthalate include all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. The starting material for the commercial production of PET are ethylene for the production of ethylene glycol and p-xylene for the production of terephthalic acid. Ethylene is produced by cracking natural gas or the naphtha fraction of crude oil. The crackers also produce small quantities of the different isomers of xylene. p-Xylene is used in the production of terephthalic acid because the ´straight´ structure of this isomer is best suited to linear polymers. In practice there are two separate routes used in the production of PET precursors. The first

	method oxidises p-xylene to terephthalic acid which is then purified. This purified terephthalic acid is then reacted with ethylene glycol to produce bishydroxyethyl terephthalate with water as a by-product. The alternative route oxidises p-xylene to terephthalic acid but then reacts the acid immediately with methanol to produce dimethyl terephtalate (DMT). When DMT is is reacted with ethylene glycol, the result is again bishydroxyethyl terephtalate but the by-product is now methanol, which can be recovered and reused. The monomer produced by either route is then polymerised in the liquid phase to amorphous polyethylene terephtalat. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and deliver; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been tracked back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 10 plants in 4 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. For raw materials, inputs as listed from APME, have been reocorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1992-1993. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data supplied by 5 polyethylene production plants in 3 countries: Germany, Netherlands and UK. Their total production was 400,000 tonnes. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Data were supplied from 5 producers in UK, Netherlands and Germany.

Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1993
Data Type	Derived, mixed
Represents	
Method	European average data. Results are based on data supplied by 5 polyethylene production plants in 3 countries: Germany, Netherlands and UK. Their total production was 400,000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports /htm/alphabetical.htm APME, PET amorphous, prod, 1 kg
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	2040.194764070241			mg	Air	Europe

	Input	Natural resource	Barytes	.2150791475579266			mg	Ground	Europe
	Input	Natural resource	Bauxite	324.1147331492073			mg	Ground	Europe
	Input	Natural resource	Bentonite	3.983435912120259			mg	Ground	Europe
	Input	Natural resource	Biomass	1043.992901627591			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	.3778723775702319			mg	Ground	Europe
	Input	Natural resource	Chalk	9.407878819567078E-024			mg	Ground	Europe
	Input	Natural resource	Clay	.2737465232399807			mg	Ground	Europe
	Input	Natural resource	Cr	7.808065243402719E-007			mg	Ground	Europe
	Input	Natural resource	Crude oil	1015416.452308652			mg	Ground	Europe
	Input	Natural resource	Dolomite	3.371808169211932			mg	Ground	Europe
	Input	Natural resource	Fe	278.0421019887073			mg	Ground	Europe
	Input	Natural resource	Feldspar	1.341544619616794E-029			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	.2505121356191798			mg	Ground	Europe
	Input	Natural resource	Fluorite	.4113717474190328			mg	Ground	Europe
	Input	Natural resource	Granite	4.215776496821321E-003			mg	Ground	Europe
	Input	Natural resource	Gravel	1.017606103718701			mg	Ground	Europe
	Input	Natural resource	Hard coal	370945.893533855			mg	Ground	Europe
	Input	Natural resource	Hydro energy	9.68166376126274E-002			MJ	Ground	Europe
	Input	Natural resource	Lignite	847.1972372833967			mg	Ground	Europe
	Input	Natural resource	Limestone	20927.90198384567			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	111.1612424520748			mg	Ground	Europe
	Input	Natural resource	Mg				mg	Ground	Europe
	Input	Natural resource	Natural gas	324856.9651055289			mg	Ground	Europe
	Input	Natural resource	Ni	3.962499030033049E-007			mg	Ground	Europe
	Input	Natural resource	Nitrogen	70876.06939745339			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	2.529588973958015			MJ	Ground	Europe
	Input	Natural resource	Olivine	2.587520244605618			mg	Ground	Europe
	Input	Natural resource	Oxygen	15.84760741878897			mg	Ground	Europe
	Input	Natural resource	Pb	1.967439828508545			mg	Ground	Europe
	Input	Natural resource	Peat	.9511795261350112			mg	Ground	Europe
	Input	Natural resource	Phosphate	.11692199709086			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	5.372477394723547E-002			mg	Ground	Europe
	Input	Natural resource	Rutile	1.350417924814906E-023			mg	Ground	Europe
	Input	Natural resource	Sand	63.62747829740228			mg	Ground	Europe
	Input	Natural resource	Shale oils	1.069756700901326			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	1443.900681762397			mg	Ground	Europe
	Input	Natural resource	Sulphur	24.95246088610721			mg	Ground	Europe

	Input	Natural resource	Sulphur (bonded)	12.35790507879544			mg	Ground	Europe
	Input	Natural resource	Talc				mg	Ground	Europe
	Input	Natural resource	Water	17583672.24455941			mg	Water	Europe
	Input	Natural resource	Wood	.8788671331678466			mg	Ground	Europe
	Input	Natural resource	Zn	7.397573755192133E-002			mg	Ground	Europe
	Output	By-product	Recovered energy	0.1763668649661109			MJ	Technosphere	Europe
	Output	By-product	To incinerator	8.714911747286894			mg	Technosphere	Europe
	Output	By-product	To recycling	.778277643634396			mg	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	3.896102298996889E-007			mg	Air	Europe
	Output	Emission	1,2-Dichloroethane	8.280568955457612E-011			mg	Water	Europe
	Output	Emission	Acid as H+	25.7320068747968			mg	Water	Europe
	Output	Emission	Al	.9105164710629108			mg	Water	Europe
	Output	Emission	Aldehydes	1.037648171079231E-003			mg	Air	Europe
	Output	Emission	As	4.032373509883151E-006			mg	Water	Europe
	Output	Emission	BOD5	895.7916693325425			mg	Water	Europe
	Output	Emission	Ca2+	.2239736369329467			mg	Water	Europe
	Output	Emission	CH4	10111.5319889409			mg	Air	Europe
	Output	Emission	Chloroorganics	2.041696840383053E-005			mg	Water	Europe
	Output	Emission	Chloroorganics	5.831450751328544E-003			mg	Air	Europe
	Output	Emission	Cl-	318.8239417884695			mg	Water	Europe
	Output	Emission	Cl2	1.829833524823906E-005			mg	Water	Europe
	Output	Emission	Cl2	6.041143570099837E-004			mg	Air	Europe
	Output	Emission	CN-	3.888327469771876E-004			mg	Water	Europe
	Output	Emission	CO	22785.19702317497			mg	Air	Europe
	Output	Emission	CO2	4142634.864549716			mg	Air	Europe
	Output	Emission	CO32-	3.24589949701424			mg	Water	Europe
	Output	Emission	COD	2212.011414502401			mg	Water	Europe
	Output	Emission	CrO3	9.394730907837492E-007			mg	Water	Europe
	Output	Emission	CS2	2.612356836609724E-006			mg	Air	Europe
	Output	Emission	Cu	5.102562862221597E-002			mg	Water	Europe
	Output	Emission	Dissolved organics	10187.15322865538			mg	Water	Europe
	Output	Emission	Dissolved solids	72.45323096608034			mg	Water	Europe
	Output	Emission	F-	5.044370875247763E-003			mg	Water	Europe
	Output	Emission	F2	1.296451602461842E-004			mg	Air	Europe
	Output	Emission	Fe	6.663693818344668E-002			mg	Water	Europe
	Output	Emission	H2	34.88202119377284			mg	Air	Europe
	Output	Emission	H2S	9.940276908937075E-003			mg	Air	Europe
	Output	Emission	H2SO4	9.436435468907723E-007			mg	Air	Europe
	Output	Emission	Halogenated hydrocarbons (chlorofluoroca	1.30894537098271E-002			mg	Air	Europe
	Output	Emission	HCl	324.3010946035992			mg	Air	Europe
	Output	Emission	HCN	4.61599099065641E-029			mg	Air	Europe
	Output	Emission	HF	9.200860421565583			mg	Air	Europe
	Output	Emission	Hg	1.363185892367444E-002			mg	Air	Europe
	Output	Emission	Hg	4.524480344317002E-005			mg	Water	Europe
	Output	Emission	K+	1.587147517326742E-003			mg	Water	Europe
	Output	Emission	Metals	213.9988302306819			mg	Air	Europe
	Output	Emission	Metals	69.53274371717754			mg	Water	Europe
	Output	Emission	Mg	2.083875241453027E-002			mg	Water	Europe
	Output	Emission	N total	.1878780936493165			mg	Water	Europe
	Output	Emission	N2O	1.318354646890349E-002			mg	Air	Europe
	Output	Emission	Na	1620.742362056924			mg	Water	Europe
	Output	Emission	NH3	5.352037987008851E-004			mg	Air	Europe
	Output	Emission	NH4+	.5124578960523999			mg	Water	Europe
	Output	Emission	Ni	5.10564436638442E-002			mg	Water	Europe
	Output	Emission	NO3-	.1445272880659424			mg	Water	Europe
	Output	Emission	NOx	19387.76946801715			mg	Air	Europe
	Output	Emission	Oil	23.83981174413444			mg	Water	Europe
	Output	Emission	P2O5	5.410311248060588			mg	Water	Europe
	Output	Emission	PAH	4.709801966889543E-002			mg	Air	Europe
	Output	Emission	Particles	6881.879580899728			mg	Air	Europe

	Output	Emission	Pb	2.207539669060726E-004			mg	Water	Europe
	Output	Emission	Pb	9.274478007790248E-005			mg	Air	Europe
	Output	Emission	Phenol	10.61226993081959			mg	Water	Europe
	Output	Emission	S2-	7.863135811667194E-003			mg	Water	Europe
	Output	Emission	SO2	41644.3584709175			mg	Air	Europe
	Output	Emission	SO42-	34.56307715177221			mg	Water	Europe
	Output	Emission	Suspended solids	358.9940221910994			mg	Water	Europe
	Output	Emission	Thiols	8.121779439486088E-004			mg	Air	Europe
	Output	Emission	Vinyl chloride	1.760394773613286E-026			mg	Water	Europe
	Output	Emission	Vinyl chloride	3.758420316688701E-007			mg	Air	Europe
	Output	Emission	VOC	.1120751299555084			mg	Water	Europe
	Output	Emission	VOC	1.733088796426251			mg	Air	Europe
	Output	Emission	VOC	123.3059171573503			mg	Water	Europe
	Output	Emission	VOC	14430.48009374043			mg	Air	Europe
	Output	Emission	VOC	9523.764508560522			mg	Air	Europe
	Output	Emission	Zn	2.530340420051596E-004			mg	Water	Europe
	Output	Product	PET, amorphous	1			kg	Technosphere	Europe
	Output	Residue	Construction	.7365976107827646			mg	Ground	Europe
	Output	Residue	Industrial	1782.230697575229			mg	Ground	Europe
	Output	Residue	Inert chemical	3750.384978081586			mg	Ground	Europe
	Output	Residue	Metals	2.203388438278732			mg	Ground	Europe
	Output	Residue	Mineral	70868.04206874449			mg	Ground	Europe
	Output	Residue	Paper & board	4.796398618704278E-023			mg	Ground	Europe
	Output	Residue	Plastics	.2091072120474258			mg	Ground	Europe
	Output	Residue	Regulated chemical	156.0274108985103			mg	Ground	Europe
	Output	Residue	Slags & ashes	21962.43623567515			mg	Ground	Europe
	Output	Residue	Unspecified	.9846577575974302			mg	Ground	Europe
	Output	Residue	Wood waste	8.787901703387087E-003			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PET. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. -- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.

Practitioner	Boustead, Ian - .
Reviewer	-
Applicability	European average data. Data were supplied from 5 producers in UK, Netherlands and Germany. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for PET production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of PET in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO_2 emission. CO_2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO_2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS

	Old name New name Aluminium ion Al Ammonium ion NH_4^+ Carbon disulfide CS_2 Carbonate CO_3^{2-} Chlorine Cl_2 Chromium oxide CrO_3 Copper (Cu^+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F_2) F_2 Hydrocyanic HCN Hydrogen H_2 Iron, Fe^{2+}, Fe^{3+} Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni^{++}) Ni Nitrate (NO_3) NO_3^- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H_2S_4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn^{++}) Zn Ni (Ni^{++}, Ni^{3+}) Ni

SPINE LCI dataset: Production of polymethyl methacrylate (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of polymethyl methacrylate (APME)
Functional Unit	1 kg of PMMA
Functional Unit Explanation	Polymethyl methacrylate (PMMA) is a transparent, colourless, thermoplastic polymer. The structure of the polymer solid gives PMMA a distinctive optical clarity. Typical uses for PMMA are baths, sinks and showers, illuminated signs, glazing, motor vehicle rear lights, medical uses such as intra-ocular lenses, contact lenses and implants.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Production of PMMA include all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. The production route of PMMA requires the production of a significant number of intermediates. Essentially the process produce acetone cyanohydrin which is then converted to methyl methacrylate. The monomer may be polymerised to produce beads which can then be extruded, or the monomer may be directly polymerised as in the production of cast sheet. There are a number of different routes to acetone but the most commonly used is as a by-product in the manufacture of phenol. Hydrogen cyanide is mainly produced by the reaction of methane (natural gas) with ammonia. A small proportion of hydrogen cyanide,

	however, is obtained as a by-product from acrylonitrile production. Acetone is then reacted with hydrogen cyanide to produce acetone cyanohydrin and this is converted to methyl methacrylate in an acid solution of sulfuric acid. The intermediate, methacrylamide sulphate is not isolated but the spent sulphuric acid from the process is recovered and regenerated for further use. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and deliver; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been tracked back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 10 plants in 4 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the years 1992-1993. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 5 polymethyl methacryalate producers in France, Italy, Netherlands and Germany. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 5 production plants in 4 countries: France, Italy, Netherlands and Germany. Their total production was 130 000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their

	calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1992-1993
Data Type	Derived, mixed
Represents	Data were supplied by the five major producers in Europe, producing 130,000 tonnes annually, and are thought to be representative of the current total production in Europe.
Method	European average data. Results are based on data supplied by 5 production plants in 4 countries: France, Italy, Netherlands and Germany. Their total production was 130 000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports/htm/alphabetical.htm
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Air	-377056.8792312741			mg	Air	Europe
	Input	Natural resource	Barytes	75.0598684835968			mg	Ground	Europe

		Input	Natural resource	Bauxite	730.9734846203144			mg	Ground	Europe
		Input	Natural resource	Bentonite	1.530958175593015			mg	Ground	Europe
		Input	Natural resource	Biomass	4777.886212566051			mg	Ground	Europe
		Input	Natural resource	Calcium sulphate	.1186671877870278			mg	Ground	Europe
		Input	Natural resource	Chalk	6.508148121177313E-024			mg	Ground	Europe
		Input	Natural resource	Clay	10.8469243872675			mg	Ground	Europe
		Input	Natural resource	Cr	3.205064034827963E-007			mg	Ground	Europe
		Input	Natural resource	Crude oil	885703.3700308161			mg	Ground	Europe
		Input	Natural resource	Dolomite	5.683224138051396			mg	Ground	Europe
		Input	Natural resource	Fe	554.9695293887921			mg	Ground	Europe
		Input	Natural resource	Feldspar	7.732089057489994E-030			mg	Ground	Europe
		Input	Natural resource	Ferromanganese	.6887725263498515			mg	Ground	Europe
		Input	Natural resource	Fluorite	11.2472779241631			mg	Ground	Europe
		Input	Natural resource	Granite	.1149401107532409			mg	Ground	Europe
		Input	Natural resource	Gravel	1.711417037210241			mg	Ground	Europe
		Input	Natural resource	Hard coal	195129.3648399469			mg	Ground	Europe
		Input	Natural resource	Hydro energy	.6118002112359568			MJ	Ground	Europe
		Input	Natural resource	Lignite	123423.6824325131			mg	Ground	Europe
		Input	Natural resource	Limestone	10037.73439771172			mg	Ground	Europe
		Input	Natural resource	Metallurgical coal	186.9234380461219			mg	Ground	Europe
		Input	Natural resource	Mg				mg	Ground	Europe
		Input	Natural resource	Natural gas	1338856.576720219			mg	Ground	Europe
		Input	Natural resource	Ni	3.31369345840972E-003			mg	Ground	Europe
		Input	Natural resource	Nitrogen	14506.39141257471			mg	Ground	Europe
		Input	Natural resource	Nuclear energy	5.243258461139293			MJ	Ground	Europe
		Input	Natural resource	Olivine	4.351709580516229			mg	Ground	Europe
		Input	Natural resource	Oxygen	131224.079620599			mg	Ground	Europe
		Input	Natural resource	Pb	3.421442307239875			mg	Ground	Europe
		Input	Natural resource	Peat	36.83846096781767			mg	Ground	Europe
		Input	Natural resource	Phosphate	2069.085565106534			mg	Ground	Europe
		Input	Natural resource	Potassium chloride	394.4798982793286			mg	Ground	Europe
		Input	Natural resource	Rutile	9.341871901994505E-024			mg	Ground	Europe
		Input	Natural resource	Sand	3405.686068173804			mg	Ground	Europe
		Input	Natural resource	Shale oils	.3359468086250759			mg	Ground	Europe
		Input	Natural resource	Sodium chloride	33282.74801654379			mg	Ground	Europe
		Input	Natural resource	Sulphur	33181.80842241043			mg	Ground	Europe
		Input	Natural resource	Sulphur (bonded)	-14867.66301947011			mg	Ground	Europe

	Input	Natural resource	Talc				mg	Ground	Europe
	Input	Natural resource	Water	35658309.04588883			mg	Water	Europe
	Input	Natural resource	Wood	59.34708460714185			mg	Ground	Europe
	Input	Natural resource	Zn	.1286462307522193			mg	Ground	Europe
	Output	By-product	Recovered energy	17.04129004785765			MJ	Technosphere	Europe
	Output	By-product	To incinerator	3.279956050740049			mg	Technosphere	Europe
	Output	By-product	To recycling	.6134065315906223			mg	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	1.12449974105318E-006			mg	Air	Europe
	Output	Emission	1,2-Dichloroethane	2.257555841784451E-009			mg	Water	Europe
	Output	Emission	Acid as H+	109.5577118251118			mg	Water	Europe
	Output	Emission	Al	.1684941176001016			mg	Water	Europe
	Output	Emission	Aldehydes	101.7482173283541			mg	Air	Europe
	Output	Emission	As	1.517920596904021E-005			mg	Water	Europe
	Output	Emission	BOD5	510.0002895107251			mg	Water	Europe
	Output	Emission	Ca2+	116.3730188501937			mg	Water	Europe
	Output	Emission	CH4	18735.13417518141			mg	Air	Europe
	Output	Emission	Chloroorganics	2.545045998398133E-002			mg	Air	Europe
	Output	Emission	Chloroorganics	9.208015508475133E-002			mg	Water	Europe
	Output	Emission	Cl-	10136.16635078949			mg	Water	Europe
	Output	Emission	Cl2	3.935327335490796E-002			mg	Water	Europe
	Output	Emission	Cl2	8.220944278626199E-003			mg	Air	Europe
	Output	Emission	CN-	3.667862046091923			mg	Water	Europe
	Output	Emission	CO	2317.114172039195			mg	Air	Europe
	Output	Emission	CO2	5584900.663389764			mg	Air	Europe
	Output	Emission	CO32-	2.817815429871273			mg	Water	Europe
	Output	Emission	COD	1494.310392800168			mg	Water	Europe
	Output	Emission	CrO3	3.856360469712788E-007			mg	Water	Europe
	Output	Emission	CS2	2.123015895546662E-006			mg	Air	Europe
	Output	Emission	Cu	.5932242077829306			mg	Water	Europe
	Output	Emission	Dissolved organics	1156.793275229758			mg	Water	Europe
	Output	Emission	Dissolved solids	626.9370451917794			mg	Water	Europe
	Output	Emission	F-	6.634305782790231			mg	Water	Europe
	Output	Emission	F2	7.113105889521845E-003			mg	Air	Europe
	Output	Emission	Fe	1.50338142054818			mg	Water	Europe
	Output	Emission	H2	786.7970507652814			mg	Air	Europe
	Output	Emission	H2S	3.666561094959852			mg	Air	Europe
	Output	Emission	H2SO4	1.086870909557105E-005			mg	Air	Europe
	Output	Emission	Halogenated hydrocarbons (chlorofluoroca	1.653044352626429E-002			mg	Air	Europe
	Output	Emission	HCl	148.65794812134			mg	Air	Europe
	Output	Emission	HCN	2.80524880517696			mg	Air	Europe
	Output	Emission	HF	7.705534155140115			mg	Air	Europe
	Output	Emission	Hg	.1079454409991583			mg	Air	Europe
	Output	Emission	Hg	3.857799413162488E-003			mg	Water	Europe
	Output	Emission	K+	11.53773592139391			mg	Water	Europe
	Output	Emission	Metals	12.93603269287869			mg	Air	Europe
	Output	Emission	Metals	212.4177221012191			mg	Water	Europe
	Output	Emission	Mg	.4851617750788693			mg	Water	Europe
	Output	Emission	N total	5.584806486097824			mg	Water	Europe
	Output	Emission	N2O	.3141941151266321			mg	Air	Europe
	Output	Emission	Na	19457.3779447903			mg	Water	Europe
	Output	Emission	NH3	7.006062093722289			mg	Air	Europe
	Output	Emission	NH4+	1105.218597163977			mg	Water	Europe
	Output	Emission	Ni	.5927309495508466			mg	Water	Europe
	Output	Emission	NO3-	2.173276705761506			mg	Water	Europe
	Output	Emission	NOx	22003.64174137344			mg	Air	Europe
	Output	Emission	Oil	62.43581057327141			mg	Water	Europe
	Output	Emission	P2O5	1022.921762803211			mg	Water	Europe
	Output	Emission	PAH				mg	Air	Europe
	Output	Emission	Particles	5094.401114624575			mg	Air	Europe
	Output	Emission	Pb	1.62575632948059E-004			mg	Air	Europe

	Output	Emission	Pb	1.829120167757652			mg	Water	Europe
	Output	Emission	Phenol	20.88943476578939			mg	Water	Europe
	Output	Emission	S2-	1.04760374402858			mg	Water	Europe
	Output	Emission	SO2	28351.64147667975			mg	Air	Europe
	Output	Emission	SO42-	27380.06442607792			mg	Water	Europe
	Output	Emission	Suspended matter (unspecified)	1887.481411147053			mg	Water	Europe
	Output	Emission	Thiols	8.856821172926504E-003			mg	Air	Europe
	Output	Emission	Vinyl chloride	1.217799480430476E-026			mg	Water	Europe
	Output	Emission	Vinyl chloride	7.518782197922217E-007			mg	Air	Europe
	Output	Emission	VOC	1.12926335726266			mg	Water	Europe
	Output	Emission	VOC	1.483010825365585			mg	Air	Europe
	Output	Emission	VOC	1876.691427110542			mg	Air	Europe
	Output	Emission	VOC	63.4126322403913			mg	Water	Europe
	Output	Emission	VOC	7207.888895875936			mg	Air	Europe
	Output	Emission	Zn	1.953190313915315E-003			mg	Water	Europe
	Output	Product	PMMA beads	1			kg	Technosphere	Europe
	Output	Residue	Construction	.3292726648267355			mg	Ground	Europe
	Output	Residue	Industrial	15901.68837854239			mg	Ground	Europe
	Output	Residue	Inert chemical	9708.329800228494			mg	Ground	Europe
	Output	Residue	Metals	57.78112993395244			mg	Ground	Europe
	Output	Residue	Mineral	62079.93170458583			mg	Ground	Europe
	Output	Residue	Paper & board	3.318035155152451E-023			mg	Ground	Europe
	Output	Residue	Plastics	11.96996322942647			mg	Ground	Europe
	Output	Residue	Regulated chemical	1352.521601529734			mg	Ground	Europe
	Output	Residue	Slags & ashes	16920.49650310251			mg	Ground	Europe
	Output	Residue	Unspecified	2.772866080228217			mg	Ground	Europe
	Output	Residue	Wood waste	.590949215508226			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PMMA beads. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. -- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .

Reviewer	-
Applicability	European average data. Data were supplied by the five major producers in Europe, producing 130,000 tonnes annually, and are thought to be representative of the current total production in Europe. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for PMMA beads production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of PMMA beads in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name

	Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

SPINE LCI dataset: Production of polyols (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of polyols (APME)
Functional Unit	1 kg polyols
Functional Unit Explanation	Polyether-polyols are one of the precursors used in the production of polyurethans (PUR). Main areas of use for polyurethans: the furniture and mattress sector, the automotive industry, the consumer sector, the buidling industry and refrigeration engineering. Other applications include coatings, adhesives, sealants, elastomers and fibres.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Polyether-polyols are one of the precursors used in the production of polyurethans (PUR). The input to the process is crude oil, natural gas and sodium chloride. There are several intermediates in the process.There are three different routes to produce propylene oxide either from benzene, iso-butane or propylene. The input to the last step, the polyol production, is ethylene oxide, propylene oxide, glycerol, other organics and inorganics and sucrose. Operating conditions: As the data are based on information from 12 plants in 4 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity

	production efficiency. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 12 polyol producers in Belgium, Netherlands, Italy and Germany. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 12 polyol production plants in 4 countries: Belgium, Netherlands, Italy and Germany. Their total production was 670 000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or

	chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, mixed
Represents	
Method	European average data. Results are based on data supplied by 12 polyol production plants in 4 countries: Belgium, Netherlands, Italy and Germany. Their total production was 670 000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Air	230434.9929			mg	Air	Europe
	Input	Natural resource	Barytes	163.8234318			mg	Ground	Europe
	Input	Natural resource	Bauxite	1964.836394			mg	Ground	Europe
	Input	Natural resource	Bentonite	71.4514731			mg	Ground	Europe
	Input	Natural resource	Biomass	127187.442			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	7.045993011			mg	Ground	Europe
	Input	Natural resource	Chalk	2.96E-17			mg	Ground	Europe
	Input	Natural resource	Clay	14.32942457			mg	Ground	Europe
	Input	Natural resource	Cr	9.216692922			mg	Ground	Europe
	Input	Natural resource	Crude oil	780541.6738			mg	Ground	Europe
	Input	Natural resource	Dolomite	426.3654206			mg	Ground	Europe
	Input	Natural resource	Fe	1417.346569			mg	Ground	Europe
	Input	Natural resource	Feldspar	768.2511796			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	1.214951316			mg	Ground	Europe
	Input	Natural resource	Fluorite	29.42799356			mg	Ground	Europe
	Input	Natural resource	Granite	5.75E-02			mg	Ground	Europe
	Input	Natural resource	Gravel	4.928873378			mg	Ground	Europe
	Input	Natural resource	Hard coal	230342.5878			mg	Ground	Europe

	Input	Natural resource	Hydro energy	0.668488228			MJ	Ground	Europe
	Input	Natural resource	Lignite	178227.8168			mg	Ground	Europe
	Input	Natural resource	Limestone	523505.1652			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	554.3580107			mg	Ground	Europe
	Input	Natural resource	Mg	1.09E-02			mg	Ground	Europe
	Input	Natural resource	Natural gas	719570.2428			mg	Ground	Europe
	Input	Natural resource	Ni	9.95E-02			mg	Ground	Europe
	Input	Natural resource	Nitrogen	70769.5063			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	6.684895928			MJ	Ground	Europe
	Input	Natural resource	Olivine	12.53290404			mg	Ground	Europe
	Input	Natural resource	Oxygen	123347.8808			mg	Ground	Europe
	Input	Natural resource	Pb	2.991413699			mg	Ground	Europe
	Input	Natural resource	Peat	345.2812884			mg	Ground	Europe
	Input	Natural resource	Phosphate	2501.759349			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	21320.22501			mg	Ground	Europe
	Input	Natural resource	Rutile	2.44E-03			mg	Ground	Europe
	Input	Natural resource	Sand	2393.260617			mg	Ground	Europe
	Input	Natural resource	Shale oils	19.94720621			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	1940347.425			mg	Ground	Europe
	Input	Natural resource	Sulphur	3954.719858			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	1954.993424			mg	Ground	Europe
	Input	Natural resource	Talc				mg	Ground	Europe
	Input	Natural resource	Water	362511430			mg	Water	Europe
	Input	Natural resource	Wood	1012.622962			mg	Ground	Europe
	Input	Natural resource	Zn	1.023196335			mg	Ground	Europe
	Output	Emission	1,2-Dichloroethane	1.58E-08			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	5.70E-04			mg	Air	Europe
	Output	Emission	Acid as H+	38.79921384			mg	Water	Europe
	Output	Emission	Al	1.58567411			mg	Water	Europe
	Output	Emission	Aldehydes	0.678977447			mg	Air	Europe
	Output	Emission	As	6.21E-04			mg	Water	Europe
	Output	Emission	BOD5	642.2501802			mg	Water	Europe
	Output	Emission	Ca2+	128838.2084			mg	Water	Europe
	Output	Emission	CFCs	12.37284579			mg	Air	Europe
	Output	Emission	Chloroorganics	0.757096881			mg	Water	Europe
	Output	Emission	Chloroorganics	30.33557165			mg	Air	Europe
	Output	Emission	Cl-	1124224.294			mg	Water	Europe
	Output	Emission	Cl2	1.796747776			mg	Air	Europe
	Output	Emission	Cl2	13.03617859			mg	Water	Europe
	Output	Emission	CN-	3.41E-02			mg	Water	Europe
	Output	Emission	CO	1847.123973			mg	Air	Europe
	Output	Emission	CO2	3099445.188			mg	Air	Europe
	Output	Emission	CO32-	2287.210505			mg	Water	Europe
	Output	Emission	COD	3429.774967			mg	Water	Europe
	Output	Emission	CrO3	10.4642742			mg	Water	Europe
	Output	Emission	CS2	1.892338737			mg	Air	Europe
	Output	Emission	Cu	0.319004093			mg	Water	Europe
	Output	Emission	Dissolved organics	283.2675141			mg	Water	Europe
	Output	Emission	Dissolved solids	7535.4041			mg	Water	Europe
	Output	Emission	F-	0.820412132			mg	Water	Europe
	Output	Emission	F2	5.33E-02			mg	Air	Europe
	Output	Emission	Fe	23.61286688			mg	Water	Europe
	Output	Emission	H2	1336.48827			mg	Air	Europe
	Output	Emission	H2S	2.38307386			mg	Air	Europe
	Output	Emission	H2SO4	0.522277332			mg	Air	Europe
	Output	Emission	HCl	184.5777507			mg	Air	Europe
	Output	Emission	HCN	1.45E-22			mg	Air	Europe
	Output	Emission	HF	8.468868887			mg	Air	Europe
	Output	Emission	Hg	0.445291041			mg	Air	Europe
	Output	Emission	Hg	3.25E-02			mg	Water	Europe
	Output	Emission	K+	405.0016682			mg	Water	Europe
	Output	Emission	Metals	140.929025			mg	Water	Europe
	Output	Emission	Metals	5.368716056			mg	Air	Europe
	Output	Emission	Methane	11769.87033			mg	Air	Europe
	Output	Emission	Mg	211.6084421			mg	Water	Europe

	Output	Emission	N total	2218.868979			mg	Water	Europe
	Output	Emission	N2O	27.9989431			mg	Air	Europe
	Output	Emission	Na	609354.8738			mg	Water	Europe
	Output	Emission	NH3	247.7017629			mg	Air	Europe
	Output	Emission	NH4+	8.667890953			mg	Water	Europe
	Output	Emission	Ni	0.320398199			mg	Water	Europe
	Output	Emission	NO3-	5972.455104			mg	Water	Europe
	Output	Emission	NOx	14194.85403			mg	Air	Europe
	Output	Emission	Oil	63.23942652			mg	Water	Europe
	Output	Emission	Other organics	302.0035275			mg	Water	Europe
	Output	Emission	PAH	2.455464955			mg	Air	Europe
	Output	Emission	Particles	10833.08996			mg	Air	Europe
	Output	Emission	Pb	3.25E-03			mg	Water	Europe
	Output	Emission	Pb	4.42E-04			mg	Air	Europe
	Output	Emission	Phenol	3.865642519			mg	Water	Europe
	Output	Emission	Phosphate	964.0060905			mg	Water	Europe
	Output	Emission	S2-	0.514868214			mg	Water	Europe
	Output	Emission	SO2	12727.74555			mg	Air	Europe
	Output	Emission	SO42-	2169.197009			mg	Water	Europe
	Output	Emission	Suspended solids	51739.32755			mg	Water	Europe
	Output	Emission	Thiols	5.95E-02			mg	Air	Europe
	Output	Emission	Vinyl chloride	7.51E-05			mg	Air	Europe
	Output	Emission	VOC	3003.521			mg	Air	Europe
	Output	Emission	VOC	35.48447388			mg	Water	Europe
	Output	Emission	Zn	1.284360956			mg	Water	Europe
	Output	Product	Polyols	1			kg	Technosphere	Europe
	Output	Residue	Construction	119.5097154			mg	Ground	Europe
	Output	Residue	Industrial	31034.36298			mg	Ground	Europe
	Output	Residue	Inert chemical	11342.75223			mg	Ground	Europe
	Output	Residue	Metals	144.931377			mg	Ground	Europe
	Output	Residue	Mineral	221237.5815			mg	Ground	Europe
	Output	Residue	Paper	1.444588709			mg	Ground	Europe
	Output	Residue	Plastics	203.3237687			mg	Ground	Europe
	Output	Residue	Recovered energy	-0.978172537			MJ	Technosphere	Europe
	Output	Residue	Regulated chemical	39956.36966			mg	Ground	Europe
	Output	Residue	Slags & ashes	20960.60807			mg	Ground	Europe
	Output	Residue	To incinerator	13471.66058			mg	Technosphere	Europe
	Output	Residue	To recycling	90.34709169			mg	Technosphere	Europe
	Output	Residue	Unspecified	24.94035737			mg	Ground	Europe
	Output	Residue	Wood waste	6.152978069			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for polyols. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. -- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 27 November 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs)

	of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .
Reviewer	
Applicability	European average data. Results are based on data supplied by 12 production plants in 4 countries: Belgium, Netherlands, Italy and Germany. Their total production was 670 000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
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Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

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SPINE LCI dataset: Production of polypropylene (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of polypropylene (APME)
Functional Unit	1 kg of PP
Functional Unit Explanation	The polyolefins are chemically the simplest of the polymers in commercial production. Typical uses for PP are injection moulded products, fibres and filaments and film and sheets. Typical uses for polypropene: - injection moulded products - fibres and filament

	- film and sheet.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Production of polypropene includes all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. PP are usually polymerised by a free radical mechanism whereby an inhibitor opens the double bond of the alkene molecule and attaches itself leaving the other 'open' bond, or radical free to attack a further alkene molecule. The process repeats itself until all of the monomer is used up or, more commonly, the reactive end is itself terminated by a specifically added reactant. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and deliver; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been tracked back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 10 plants in 4 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1992-1993. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 15 polypropylene producers in Austria, Belgium, Finland, Netherlands, Norway, Portugal, UK. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment

	and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Data were supplied from 15 producers in Austria, Belgium, Finland, Netherlands, Norway, Portugal, UK.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1992-1993
Data Type	Derived, mixed
Represents	
Method	European average data. Results are based on data supplied by 15 PP production plants in 7countries: Austria, Belgium, Finland, Netherlands, Norway, Portugal and UK. Their total production was 1,580,000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports /htm/alphabetical.htm www.lca.apme.org
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-

	product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Air	172911.6179			mg	Air	Europe
	Input	Natural resource	Barytes	7.25E-02			mg	Ground	Europe
	Input	Natural resource	Bauxite	2336.770595			mg	Ground	Europe
	Input	Natural resource	Bentonite	26.15882874			mg	Ground	Europe
	Input	Natural resource	Biomass	4011.647989			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	2.607422303			mg	Ground	Europe
	Input	Natural resource	Chalk	3.20E-22			mg	Ground	Europe
	Input	Natural resource	Clay	13.67900065			mg	Ground	Europe
	Input	Natural resource	Cr	2.98E-05			mg	Ground	Europe
	Input	Natural resource	Crude oil	940749.0924			mg	Ground	Europe
	Input	Natural resource	Dolomite	1.409815416			mg	Ground	Europe
	Input	Natural resource	Fe	182.2943098			mg	Ground	Europe
	Input	Natural resource	Feldspar	4.79E-28			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	0.103534437			mg	Ground	Europe
	Input	Natural resource	Fluorite	31.77608671			mg	Ground	Europe
	Input	Natural resource	Granite	26.77344535			mg	Ground	Europe
	Input	Natural resource	Gravel	0.420567546			mg	Ground	Europe
	Input	Natural resource	Hard coal	62219.88074			mg	Ground	Europe
	Input	Natural resource	Hydro energy	0.5331366			MJ	Ground	Europe
	Input	Natural resource	Lignite	3876.272574			mg	Ground	Europe
	Input	Natural resource	Limestone	558.7919298			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	46.23598591			mg	Ground	Europe
	Input	Natural resource	Mg	0			mg	Ground	Europe
	Input	Natural resource	Natural gas	586332.944			mg	Ground	Europe
	Input	Natural resource	Ni	7.31E-06			mg	Ground	Europe
	Input	Natural resource	Nitrogen	66654.54566			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	1.939620394			MJ	Ground	Europe
	Input	Natural resource	Olivine	1.069399088			mg	Ground	Europe
	Input	Natural resource	Oxygen	32.16695282			mg	Ground	Europe
	Input	Natural resource	Pb	0.221873136			mg	Ground	Europe
	Input	Natural resource	Peat	2573.032535			mg	Ground	Europe
	Input	Natural resource	Phosphate	0.315322522			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	0.999572211			mg	Ground	Europe

	Input	Natural resource	Rutile	4.59E-22			mg	Ground	Europe
	Input	Natural resource	Sand	129.6732646			mg	Ground	Europe
	Input	Natural resource	Shale oils	7.381612541			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	2715.530456			mg	Ground	Europe
	Input	Natural resource	Sulphur	58.51543845			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	24.8926685			mg	Ground	Europe
	Input	Natural resource	Talc	0			mg	Ground	Europe
	Input	Natural resource	Water	60982261.13			mg	Water	Europe
	Input	Natural resource	Wood	2.461881994			mg	Ground	Europe
	Input	Natural resource	Zn	8.34E-03			mg	Ground	Europe
	Output	By-product	Recovered energy	0.926792717			MJ	Technosphere	Europe
	Output	By-product	To incinerator	285.6717996			mg	Technosphere	Europe
	Output	By-product	To recycling	10.16283658			mg	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	0.00E+00			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	1.15E-07			mg	Air	Europe
	Output	Emission	Acid as H+	55.89002837			mg	Water	Europe
	Output	Emission	Aldehydes	2.80E-03			mg	Air	Europe
	Output	Emission	As	6.07E-05			mg	Water	Europe
	Output	Emission	BOD5	33.93998082			mg	Water	Europe
	Output	Emission	Ca2+	0.549568304			mg	Water	Europe
	Output	Emission	CH4	6056.63207			mg	Air	Europe
	Output	Emission	Chloroorganics	2.00E-04			mg	Water	Europe
	Output	Emission	Chloroorganics	2.47E-03			mg	Air	Europe
	Output	Emission	Cl-	1257.547787			mg	Water	Europe
	Output	Emission	Cl2	0.299357995			mg	Air	Europe
	Output	Emission	Cl2	3.39E-04			mg	Water	Europe
	Output	Emission	CN-	0.199085998			mg	Water	Europe
	Output	Emission	CO	721.4472223			mg	Air	Europe
	Output	Emission	CO2	1852131.455			mg	Air	Europe
	Output	Emission	CO32-	31.43240577			mg	Water	Europe
	Output	Emission	COD	178.9270144			mg	Water	Europe
	Output	Emission	CrO3	3.59E-05			mg	Water	Europe
	Output	Emission	CS2	6.28E-05			mg	Air	Europe
	Output	Emission	Cu	6.06E-02			mg	Water	Europe
	Output	Emission	Dissolved organics	64.58853915			mg	Water	Europe
	Output	Emission	Dissolved solids	103.4320855			mg	Water	Europe
	Output	Emission	F-	0.886410762			mg	Water	Europe
	Output	Emission	F2	2.45E-02			mg	Air	Europe
	Output	Emission	Fe	0.182216488			mg	Water	Europe
	Output	Emission	H2	77.39943352			mg	Air	Europe
	Output	Emission	H2S	1.483703835			mg	Air	Europe
	Output	Emission	H2SO4	1.07E-06			mg	Air	Europe
	Output	Emission	Halogenated hydrocarbons (chlorofluoroca	8.10E-02			mg	Air	Europe
	Output	Emission	HCl	32.96226294			mg	Air	Europe
	Output	Emission	HCN	1.57E-27			mg	Air	Europe
	Output	Emission	HF	1.489516775			mg	Air	Europe
	Output	Emission	Hg	0.39063626			mg	Air	Europe
	Output	Emission	Hg	2.30E-02			mg	Water	Europe
	Output	Emission	K+	2.96E-02			mg	Water	Europe
	Output	Emission	Metals	57.39399702			mg	Water	Europe
	Output	Emission	Metals	7.441889581			mg	Air	Europe
	Output	Emission	Mg	4.52E-02			mg	Water	Europe
	Output	Emission	N total	4.595581085			mg	Water	Europe
	Output	Emission	N2O	6.37E-02			mg	Air	Europe
	Output	Emission	Na	249.7234335			mg	Water	Europe
	Output	Emission	NH3	1.33E-03			mg	Air	Europe
	Output	Emission	NH4+	9.516596988			mg	Water	Europe

	Output	Emission	Ni	5.93E-02			mg	Water	Europe
	Output	Emission	NO3-	18.30792701			mg	Water	Europe
	Output	Emission	NOx	9576.042505			mg	Air	Europe
	Output	Emission	Oil	68.83557923			mg	Water	Europe
	Output	Emission	P2O5	3.388090591			mg	Water	Europe
	Output	Emission	PAH	2.56E-28			mg	Air	Europe
	Output	Emission	Particles	1489.417379			mg	Air	Europe
	Output	Emission	Pb	1.89E-02			mg	Water	Europe
	Output	Emission	Pb	3.83E-05			mg	Air	Europe
	Output	Emission	Phenol	3.816517211			mg	Water	Europe
	Output	Emission	S2-	0.739519657			mg	Water	Europe
	Output	Emission	SO2	12904.31318			mg	Air	Europe
	Output	Emission	SO42-	56.13088216			mg	Water	Europe
	Output	Emission	Suspended solids	342.818065			mg	Water	Europe
	Output	Emission	Thiols	1.89E-02			mg	Air	Europe
	Output	Emission	Vinyl chloride	18.01909858			mg	Water	Europe
	Output	Emission	Vinyl chloride	5.98E-25			mg	Water	Europe
	Output	Emission	Vinyl chloride	7.44E-08			mg	Air	Europe
	Output	Emission	VOC	0.70519843			mg	Air	Europe
	Output	Emission	VOC	1.205374261			mg	Water	Europe
	Output	Emission	VOC	2.517697082			mg	Air	Europe
	Output	Emission	VOC	2347.518303			mg	Air	Europe
	Output	Emission	VOC	51.41348349			mg	Water	Europe
	Output	Emission	Zn	0.312073394			mg	Water	Europe
	Output	Product	PP	1			kg	Technosphere	Europe
	Output	Residue	Construction	194.9191564			mg	Ground	Europe
	Output	Residue	Industrial	2062.589981			mg	Ground	Europe
	Output	Residue	Inert chemical	469.4742736			mg	Ground	Europe
	Output	Residue	Metals	122.8787308			mg	Ground	Europe
	Output	Residue	Mineral	16789.52244			mg	Ground	Europe
	Output	Residue	Paper & board	1.63E-21			mg	Ground	Europe
	Output	Residue	Plastics	24.51584986			mg	Ground	Europe
	Output	Residue	Regulated chemical	11186.17056			mg	Ground	Europe
	Output	Residue	Slags & ashes	3939.197515			mg	Ground	Europe
	Output	Residue	Unspecified	5.997848138			mg	Ground	Europe
	Output	Residue	Wood waste	2.46E-02			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PP. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. -- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems.

	- Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .
Reviewer	-
Applicability	European average data. Data were supplied by the 15 major producers in Austria, Belgium, Finland, Netherlands, Norway, Portugal, UK, producing 1,580,000 tonnes annually. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for PP production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of PP in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy

	Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

SPINE LCI dataset: Production of polystyrene (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of polystyrene (APME)
Functional Unit	1 kg of PS (General purpose)
Functional Unit Explanation	PS, Polystyrene is a versatile polymer resin used in a wide range of applications - especially in the packaging industry. I Typical uses for polystyrene: - packaging - electronics.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe

Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Production of polystyrene include all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. The production of styrene monomer can be thought of as replacing one of the hydrogen atoms in ethylene by a benzene ring. The monomer is then polymerised, the double bonds in the monomer molecules are opened and neighbouring molecules link together to form a chain. Crude oil refining produces a fraction, naphtha, which contains a mixture of low molecular weight, saturated hydrocarbons of various composition. This is converted into a smaller group of unsaturated hydrocarbons by cracking - a process in which the naphtha is heated to a high temperature in the absence of air, maintained for a short time at this high temperature and then very rapidly cooled back to a low temperature when all the reactions stop and the mix of products is essentially fixed. The resulting mixture is then separated into its constituent components by distillation producing principally ethylene (C_2H_4), propylene (C_3H_6), mixed butenes of general formula (C_4H_8) and a number of other compounds which find uses elsewhere in the petrochemical plant either as feedstocks or fuels. The precise mix of products from cracking are determined by a number of factors such as cracker temperature, residence time and the nature of the feedstock and the operation of a cracker can often be adjusted to produce the required mix of products. Natural gas is also converted into ethylene, propylene, butenes and other products by cracking. Although benzene is usually present in small quantities in crude oil, its direct extraction is usually uneconomic. However, one by product of naphtha cracking is a liquid usually referred to as pyrolysis gasoline which is high in unsaturated aliphatic and aromatic hydrocarbons. The benzene fraction in pyrolysis gasoline can be extracted by repeated distillation and it is thought that about half of all benzene used in Europe is produced in this way. Benzene is also produced directly from naphtha by a process known as catalytic reforming. The basic feedstock is converted into a mixture of products of which the principal components are benzene, toluene and xylene (the process is often referred to as the BTX process). Benzene and other aromatics are isolated in the pure state from the output of the reformer by solvent extraction and fractional distillation. In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and deliver; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been tracked back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 10 plants in 4 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1994. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 15 polystyrene producers in Belgium, France, Germany, Italy, Netherlands, Sweden, UK. For the APME Eco-profiles in general, the coverage of European production varies from 60

	to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Data were supplied from 15 producers in Belgium, France, Germany, Italy, Netherlands, Sweden, UK.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	Derived, mixed
Represents	
Method	European average data. Results are based on data supplied by 15 polystyrene production plants in 7 countries: Belgium, France, Germany, Italy, Netherlands, Sweden and UK. Their total production was 810 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific

	values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports/htm/alphabetical.htm
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	112317.0329523588			mg	Air	Europe
	Input	Natural resource	Barytes	.1556033766631935			mg	Ground	Europe
	Input	Natural resource	Bauxite	928.0027467139198			mg	Ground	Europe
	Input	Natural resource	Bentonite	206.3607002917394			mg	Ground	Europe
	Input	Natural resource	Biomass	1374.26371708635			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	20.57146392382959			mg	Ground	Europe
	Input	Natural resource	Chalk	2.914429219368164E-022			mg	Ground	Europe
	Input	Natural resource	Clay	17.0489118930082			mg	Ground	Europe
	Input	Natural resource	Cr	2.550743463137298E-005			mg	Ground	Europe
	Input	Natural resource	Crude oil	738990.5824673861			mg	Ground	Europe
	Input	Natural resource	Dolomite	10.72094716751411			mg	Ground	Europe
	Input	Natural resource	Fe	955.5957205279658			mg	Ground	Europe
	Input	Natural resource	Feldspar	4.248914434931483E-028			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	.790603511808659			mg	Ground	Europe
	Input	Natural resource	Fluorite	9.246963676218607			mg	Ground	Europe
	Input	Natural resource	Granite	4.438920028962666E-003			mg	Ground	Europe
	Input	Natural resource	Gravel	3.211512921817537			mg	Ground	Europe
	Input	Natural resource	Hard coal	57649.5501890782			mg	Ground	Europe
	Input	Natural resource	Hydro energy	.1230463949240095			MJ	Ground	Europe
	Input	Natural resource	Lignite	8255.519862320545			mg	Ground	Europe
	Input	Natural resource	Limestone	1385.639810110012			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	351.5840585937242			mg	Ground	Europe
	Input	Natural resource	Mg				mg	Ground	Europe
	Input	Natural resource	Natural gas	1052544.556617431			mg	Ground	Europe
	Input	Natural resource	Ni	6.68544277352988E-006			mg	Ground	Europe
	Input	Natural resource	Nitrogen	35908.65878795025			mg	Ground	Europe

	Input	Natural resource	Nuclear energy	1.605826360878712			MJ	Ground	Europe
	Input	Natural resource	Olivine	8.166081817560057			mg	Ground	Europe
	Input	Natural resource	Oxygen	28.01074067121385			mg	Ground	Europe
	Input	Natural resource	Pb	1.544688531862321			mg	Ground	Europe
	Input	Natural resource	Peat	13.1816201968585			mg	Ground	Europe
	Input	Natural resource	Phosphate	.1231036887493185			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	1.567295197811494			mg	Ground	Europe
	Input	Natural resource	Rutile	4.183405775012087E-022			mg	Ground	Europe
	Input	Natural resource	Sand	112.4260528446837			mg	Ground	Europe
	Input	Natural resource	Shale oils	58.23781436836158			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	1939.646944824384			mg	Ground	Europe
	Input	Natural resource	Sulphur	98.47381937366649			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	34.26110246963088			mg	Ground	Europe
	Input	Natural resource	Talc				mg	Ground	Europe
	Input	Natural resource	Water	181519944.7438363			mg	Water	Europe
	Input	Natural resource	Wood	1.180592103592746			mg	Ground	Europe
	Input	Natural resource	Zn	5.80802887980233E-002			mg	Ground	Europe
	Output	By-product	Recovered energy	3.60144030535957			MJ	Technosphere	Europe
	Output	By-product	To incinerator	3750.963786085616			mg	Technosphere	Europe
	Output	By-product	To recycling	103.3021421297996			mg	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	4.678453618586037E-008			mg	Air	Europe
	Output	Emission	1,2-Dichloroethane	8.728478504125986E-011			mg	Water	Europe
	Output	Emission	Acid as H+	39.04073434702335			mg	Water	Europe
	Output	Emission	Al	96.72310804219745			mg	Water	Europe
	Output	Emission	Aldehydes	1.096572710364669E-003			mg	Air	Europe
	Output	Emission	As	3.629308887132324E-004			mg	Water	Europe
	Output	Emission	BOD5	46.14190019342994			mg	Water	Europe
	Output	Emission	Ca2+	1.587145872993741			mg	Water	Europe
	Output	Emission	CH4	8993.83732231867			mg	Air	Europe
	Output	Emission	Chloroorganics	.3051516086460218			mg	Air	Europe
	Output	Emission	Chloroorganics	1.709437499649957E-004			mg	Water	Europe
	Output	Emission	Cl-	5502.28958475167			mg	Water	Europe
	Output	Emission	Cl2	1.568120497236161E-003			mg	Water	Europe
	Output	Emission	Cl2	4.80601563313992E-002			mg	Air	Europe
	Output	Emission	CN-	1.538006112686534E-002			mg	Water	Europe
	Output	Emission	CO	1621.994133656079			mg	Air	Europe
	Output	Emission	CO2	2.56e+006			mg	Air	Europe
	Output	Emission	CO32-	186.7483013536462			mg	Water	Europe
	Output	Emission	COD	332.4102829702067			mg	Water	Europe
	Output	Emission	CrO3	3.069076359389796E-005			mg	Water	Europe
	Output	Emission	CS2	0.000335			mg	Air	Europe
	Output	Emission	Cu	.2138445461057238			mg	Water	Europe
	Output	Emission	Dissolved organics	29.00591279274379			mg	Water	Europe
	Output	Emission	Dissolved solids	100.1413600029445			mg	Water	Europe
	Output	Emission	F-	.2570429568343187			mg	Water	Europe
	Output	Emission	F2	7.092429884065701E-003			mg	Air	Europe
	Output	Emission	Fe	9.571497225886696E-002			mg	Water	Europe
	Output	Emission	H2	42.13896021543835			mg	Air	Europe
	Output	Emission	H2S	.4736416287588353			mg	Air	Europe
	Output	Emission	H2SO4	4.327446862263907E-007			mg	Air	Europe

	Output	Emission	Halogenated hydrocarbons (chlorofluoroca	.6596453408408853			mg	Air	Europe
	Output	Emission	HCl	25.84333192749742			mg	Air	Europe
	Output	Emission	HCN	1.429969420049175E-027			mg	Air	Europe
	Output	Emission	HF	1.199133788472837			mg	Air	Europe
	Output	Emission	Hg	3.503396689882874E-003			mg	Water	Europe
	Output	Emission	Hg	6.150184280523579E-002			mg	Air	Europe
	Output	Emission	K+	4.775446975026602E-002			mg	Water	Europe
	Output	Emission	Metals	3.92261726908177			mg	Air	Europe
	Output	Emission	Metals	381.6494074739971			mg	Water	Europe
	Output	Emission	Mg	1.886526657264148E-002			mg	Water	Europe
	Output	Emission	N total	6.871230185694563			mg	Water	Europe
	Output	Emission	N2O	9.675997532546134E-002			mg	Air	Europe
	Output	Emission	Na	544.5274457885787			mg	Water	Europe
	Output	Emission	NH3	4.872757148052952E-002			mg	Air	Europe
	Output	Emission	NH4+	7.573738965421692			mg	Water	Europe
	Output	Emission	Ni	.2114825885944643			mg	Water	Europe
	Output	Emission	NO3-	2.903798922613719			mg	Water	Europe
	Output	Emission	NOx	11269.13597608281			mg	Air	Europe
	Output	Emission	Oil	57.36459053897102			mg	Water	Europe
	Output	Emission	P2O5	.6118771216577485			mg	Water	Europe
	Output	Emission	PAH	6.2424			mg	Air	Europe
	Output	Emission	Particles	1516.958725018828			mg	Air	Europe
	Output	Emission	Pb	1.000492969646761E-003			mg	Water	Europe
	Output	Emission	Pb	2.838596338209469E-004			mg	Air	Europe
	Output	Emission	Phenol	4.978449666439944			mg	Water	Europe
	Output	Emission	S2-	.5820298307773472			mg	Water	Europe
	Output	Emission	SO2	9457.415758526307			mg	Air	Europe
	Output	Emission	SO42-	262.5566256234382			mg	Water	Europe
	Output	Emission	Suspended solids	310.8595415536154			mg	Water	Europe
	Output	Emission	Thiols	9.443443329176529E-002			mg	Air	Europe
	Output	Emission	Vinyl chloride	2.903999299387604E-008			mg	Air	Europe
	Output	Emission	Vinyl chloride	5.453456686932174E-025			mg	Water	Europe
	Output	Emission	VOC	1.589268303203994			mg	Air	Europe
	Output	Emission	VOC	1.731174375334177			mg	Water	Europe
	Output	Emission	VOC	211.0726751063171			mg	Air	Europe
	Output	Emission	VOC	2627.162993165765			mg	Air	Europe
	Output	Emission	VOC	94.126776268501			mg	Water	Europe
	Output	Emission	Zn	4.636442023864456E-002			mg	Water	Europe
	Output	Product	PS	1			kg	Technosphere	Europe
	Output	Residue	Construction	21.1415191587724			mg	Ground	Europe
	Output	Residue	Industrial	1536.384070857728			mg	Ground	Europe
	Output	Residue	Inert chemical	2325.312741330034			mg	Ground	Europe
	Output	Residue	Metals	6.396761885934358			mg	Ground	Europe
	Output	Residue	Mineral	15165.12572161292			mg	Ground	Europe
	Output	Residue	Paper & board	1.485857178880213E-021			mg	Ground	Europe
	Output	Residue	Plastics	2.090853992746271			mg	Ground	Europe
	Output	Residue	Regulated chemical	682.4745865684212			mg	Ground	Europe
	Output	Residue	Slags & ashes	2966.187216974314			mg	Ground	Europe
	Output	Residue	Unspecified	15.34993727920153			mg	Ground	Europe
	Output	Residue	Wood waste	1.179673439786588E-002			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PS (General purpose). ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. -- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --

Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .
Reviewer	-
Applicability	European average data. Data were supplied from 15 producers in Belgium, France, Germany, Italy, Netherlands, Sweden, UK. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for PS (General purpose) production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of PS (General purpose) in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The

	following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

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SPINE LCI dataset: Production of polyvinyl chloride, emulsion polymerised (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System

Name	Production of polyvinyl chloride, emulsion polymerised (APME)
Functional Unit	1 kg of PVC (e)
Functional Unit Explanation	PVC (e) - (Poly Vinyl Chloride, emulsion polymerised) is a chlorinated hydrocarbon polymer. The polymer is produced from vinyl chloride by a process essentially similar to that used in the production of polyethylene, polypropylene and polystyrene. Emulsion polymerised PVC is mainly used for coating applications such as PVC coated fabrics.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. The PVC polymer is produced from vinyl chloride by a process where the double bond in the vinyl chloride is opened and neighbouring molecules combine with each other to produce a long chain molecule. The starting raw material for PVC are crude oil and natural gas for the hydrocarbon part of the molecule and naturally occuring sodium chloride (and to a lesser extent, potassium chloride) for the chlorine part. The hydrocarbon feedstocks are converted by cracking to ethylene (ethene). The sodium chloride is electrolysed as an aqueous solution to produce chlorine with sodium hydroxide and hydrogen as co-products. The ethylene and chlorine are reacted to produce 1,2-dichloroethane (ethylene dichloride) (reaction 1). The 1,2-dichloroethane is then decomposed by heating in a high temperature furnace (cracking) when it produces vinyl chloride and hydrogen chloride (reaction 2). If the process were stopped at this stage, it is clear that 50% of the input of chlorine would be lost from the system and, unless there were a sufficient demand for hydrogen chloride, this would represent a significant loss of raw materials. In practice, however, the hydrogen chloride from reaction (2) is reacted with further ethylene in the presence of oxygen (a reaction known as oxychlorination), to produce further 1,2-dichloroethane (reaction 3). The dichloroethane is now decomposed according to reaction (2). By matching the direct and oxychlorination steps, the overall reaction adds reaction (1), (2) and (3). The chlorine is now completely used by the overall process. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1992-1993. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 5 polyvinyl chloride producers in France, Germany, UK. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.

Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 5 production plants in 3 countries: France, Germany, UK. Their total production was 510,000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1992-1993
Data Type	Derived, mixed
Represents	
Method	European average data. Results are based on data supplied by 5 production plants in 3 countries: France, Germany, UK. Their total production was 510,000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports/htm/alphabetical.htm

Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	514233.4400266088			mg	Air	Europe
	Input	Natural resource	Barytes	211.4699367726962			mg	Ground	Europe
	Input	Natural resource	Bauxite	326.8207604463478			mg	Ground	Europe
	Input	Natural resource	Bentonite	37.10403646715775			mg	Ground	Europe
	Input	Natural resource	Biomass	8032.247463377484			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	3.692505434219154			mg	Ground	Europe
	Input	Natural resource	Chalk	2.475078264572807E-014			mg	Ground	Europe
	Input	Natural resource	Clay	8.716182848266222			mg	Ground	Europe
	Input	Natural resource	Cr	4.301679533248196E-005			mg	Ground	Europe
	Input	Natural resource	Crude oil	500462.1223007817			mg	Ground	Europe
	Input	Natural resource	Dolomite	2.984210779864584			mg	Ground	Europe
	Input	Natural resource	Fe	284.5801902260429			mg	Ground	Europe
	Input	Natural resource	Feldspar	2.081247145744508E-020			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	.2190256004296751			mg	Ground	Europe
	Input	Natural resource	Fluorite	3.320439041930851			mg	Ground	Europe
	Input	Natural resource	Granite	9.331254669611569E-002			mg	Ground	Europe
	Input	Natural resource	Gravel	.8897044699408504			mg	Ground	Europe
	Input	Natural resource	Hard coal	168462.417970263			mg	Ground	Europe
	Input	Natural resource	Hydro energy	.8388300259754076			MJ	Ground	Europe
	Input	Natural resource	Lignite	39085.10368543249			mg	Ground	Europe
	Input	Natural resource	Limestone	11333.0551685814			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	97.64000615013602			mg	Ground	Europe
	Input	Natural resource	Mg				mg	Ground	Europe
	Input	Natural resource	Natural gas	588724.0363587034			mg	Ground	Europe
	Input	Natural resource	Ni	3.30922541537814E-005			mg	Ground	Europe
	Input	Natural resource	Nitrogen	17422.23571730799			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	6.816628513874392			MJ	Ground	Europe
	Input	Natural resource	Olivine	2.262298073169226			mg	Ground	Europe
	Input	Natural resource	Oxygen	23842.07365269833			mg	Ground	Europe

		Input	Natural resource	Pb	.8943135394603129			mg	Ground	Europe
		Input	Natural resource	Peat	32.25535367012879			mg	Ground	Europe
		Input	Natural resource	Phosphate	2.589478064054697			mg	Ground	Europe
		Input	Natural resource	Potassium chloride	171.1344382120601			mg	Ground	Europe
		Input	Natural resource	Rutile	3.552756277905262E-014			mg	Ground	Europe
		Input	Natural resource	Sand	792.0591094918788			mg	Ground	Europe
		Input	Natural resource	Shale oils	10.45348288427442			mg	Ground	Europe
		Input	Natural resource	Sodium chloride	701544.7321270085			mg	Ground	Europe
		Input	Natural resource	Sulphur	14319.12109261565			mg	Ground	Europe
		Input	Natural resource	Sulphur (bonded)	7153.32958315641			mg	Ground	Europe
		Input	Natural resource	Talc	0			mg	Ground	Europe
		Input	Natural resource	Water	56849899.54825351			mg	Water	Europe
		Input	Natural resource	Wood	30.17844808561658			mg	Ground	Europe
		Input	Natural resource	Zn	3.362618908371777E-002			mg	Ground	Europe
		Output	By-product	Recovered energy	0.7330703184148345			MJ	Technosphere	Europe
		Output	By-product	To incinerator	36.53454853838455			mg	Technosphere	Europe
		Output	By-product	To recycling	16.33940585385982			mg	Technosphere	Europe
		Output	Emission	1,2-Dichloroethane	2.983473501494428			mg	Water	Europe
		Output	Emission	1,2-Dichloroethane	531.7874865200195			mg	Air	Europe
		Output	Emission	Acid as H+	37.99007697707466			mg	Water	Europe
		Output	Emission	Al	.3880206648021741			mg	Water	Europe
		Output	Emission	Aldehydes	2.297161116804829E-002			mg	Air	Europe
		Output	Emission	As	1.075092737833121E-004			mg	Water	Europe
		Output	Emission	BOD5	57.91995221005016			mg	Water	Europe
		Output	Emission	Ca2+	26.60274337665055			mg	Water	Europe
		Output	Emission	CH4	11072.80265164413			mg	Air	Europe
		Output	Emission	Chloroorganics	.4950121639011454			mg	Water	Europe
		Output	Emission	Chloroorganics	43.21370501941019			mg	Air	Europe
		Output	Emission	Cl-	28963.79458842633			mg	Water	Europe
		Output	Emission	Cl2	3.124138597320417			mg	Air	Europe
		Output	Emission	Cl2	2.189711443104095E-002			mg	Water	Europe
		Output	Emission	CN-	2.01218286507141E-002			mg	Water	Europe
		Output	Emission	CO	2109.641906383148			mg	Air	Europe
		Output	Emission	CO2	2512365.092946496			mg	Air	Europe
		Output	Emission	CO32-	40.89536476050134			mg	Water	Europe
		Output	Emission	COD	1385.072244278015			mg	Water	Europe
		Output	Emission	CrO3	5.175817620218134E-005			mg	Water	Europe
		Output	Emission	CS2	9.959213970610655E-005			mg	Air	Europe
		Output	Emission	Cu	.711228476757697			mg	Water	Europe
		Output	Emission	Dissolved organics	820.6154918238642			mg	Water	Europe
		Output	Emission	Dissolved solids	481.3643934965484			mg	Water	Europe
		Output	Emission	F-	6.624990952523891E-003			mg	Water	Europe
		Output	Emission	F2	1.838008521526192E-004			mg	Air	Europe
		Output	Emission	Fe	1.441049968773293			mg	Water	Europe
		Output	Emission	H2	661.4176088303527			mg	Air	Europe
		Output	Emission	H2S	1.749702062405979			mg	Air	Europe
		Output	Emission	H2SO4	3.505392699271223E-005			mg	Air	Europe
		Output	Emission	Halogenated hydrocarbons (chlorofluoroca	.5614634153650108			mg	Air	Europe
		Output	Emission	HCl	108.414294061725			mg	Air	Europe
		Output	Emission	HCN	1.214401161999998E-019			mg	Air	Europe
		Output	Emission	HF	3.776068481089089			mg	Air	Europe
		Output	Emission	Hg	.4448803188275433			mg	Air	Europe
		Output	Emission	Hg	2.272729929143962E-002			mg	Water	Europe

	Output	Emission	K+	5.373173071906923			mg	Water	Europe
	Output	Emission	Metals	6.575867492147697			mg	Air	Europe
	Output	Emission	Metals	97.91656450204103			mg	Water	Europe
	Output	Emission	Mg	1.740048047374159			mg	Water	Europe
	Output	Emission	N total	1.127180585145531			mg	Water	Europe
	Output	Emission	N2O	.2952080100388818			mg	Air	Europe
	Output	Emission	Na	4956.389784726993			mg	Water	Europe
	Output	Emission	NH3	81.10101096344118			mg	Air	Europe
	Output	Emission	NH4+	6.564634602570727			mg	Water	Europe
	Output	Emission	Ni	.5874009358403506			mg	Water	Europe
	Output	Emission	NO3-	1.899677319523036			mg	Water	Europe
	Output	Emission	NOx	13797.41155764951			mg	Air	Europe
	Output	Emission	Oil	43.2865865987956			mg	Water	Europe
	Output	Emission	P2O5	1.506091352983963			mg	Water	Europe
	Output	Emission	PAH	0			mg	Air	Europe
	Output	Emission	Particles	3581.803818815736			mg	Air	Europe
	Output	Emission	Pb	2.559033829027198E-003			mg	Water	Europe
	Output	Emission	Pb	9.710634207577781E-005			mg	Air	Europe
	Output	Emission	Phenol	6.752343430893892			mg	Water	Europe
	Output	Emission	S2-	.9705464909576298			mg	Water	Europe
	Output	Emission	SO2	13465.00623314086			mg	Air	Europe
	Output	Emission	SO42-	2840.430433976289			mg	Water	Europe
	Output	Emission	Suspended solids	3780.449368387115			mg	Water	Europe
	Output	Emission	Thiols	2.85176678556315E-002			mg	Air	Europe
	Output	Emission	Vinyl chloride	30.1075302540174			mg	Water	Europe
	Output	Emission	Vinyl chloride	565.2308358906616			mg	Air	Europe
	Output	Emission	VOC	1.059857008944798			mg	Air	Europe
	Output	Emission	VOC	2.479045210959317			mg	Water	Europe
	Output	Emission	VOC	2216.91591637181			mg	Air	Europe
	Output	Emission	VOC	28.68462241969907			mg	Water	Europe
	Output	Emission	VOC	5.468985514002338			mg	Air	Europe
	Output	Emission	Zn	5.811019456647425E-003			mg	Water	Europe
	Output	Product	PVC (e)	1			kg	Technosphere	Europe
	Output	Residue	Construction	14.30668105744033			mg	Ground	Europe
	Output	Residue	Industrial	9995.576171153925			mg	Ground	Europe
	Output	Residue	Inert chemical	14343.7662054001			mg	Ground	Europe
	Output	Residue	Metals	49.01426402887436			mg	Ground	Europe
	Output	Residue	Mineral	44436.3255617968			mg	Ground	Europe
	Output	Residue	Paper & board	1.261863826805571E-013			mg	Ground	Europe
	Output	Residue	Plastics	10583.1908460092			mg	Ground	Europe
	Output	Residue	Regulated chemical	2377.900312101898			mg	Ground	Europe
	Output	Residue	Slags & ashes	10108.35438123984			mg	Ground	Europe
	Output	Residue	Unspecified	11.6009319636585			mg	Ground	Europe
	Output	Residue	Wood waste	.3017436233253221			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PVC (e). ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. -- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for

	improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .
Reviewer	-
Applicability	European average data. Results are based on data supplied by 5 production plants in 3 countries: France, Germany, UK. Their total production was 510,000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for PVC (e) production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of PVC (e) in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO_2 emission. CO_2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO_2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).

Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

SPINE LCI dataset: Production of polyvinyl chloride, suspension polymerised (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of polyvinyl chloride, suspension polymerised (APME)
Functional Unit	1 kg of PVC (s)
Functional Unit Explanation	PVC (Poly Vinyl Chloride), is a chlorinated hydrocarbon polymer. The polymer is produced from vinyl chloride. Typical uses for suspension PVC: it is the general purpose grade and is used for most rigid PVC applications such as pipes, profiles and other building materials. It is also used for most flexible applications such as cable insulation, foils and various products made by

	injection moulding.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired.. The PVC polymer is produced from vinyl chloride by a process where the double bond in the vinyl chloride is opened and neighbouring molecules combine with each other to produce a long chain molecule. The starting raw material for PVC are crude oil and natural gas for the hydrocarbon part of the molecule and naturally occuring sodium chloride (and to a lesser extent, potassium chloride) for the chlorine part. The hydrocarbon feedstocks are converted by cracking to ethylene (ethene). The sodium chloride is electrolysed as an aqueous solution to produce chlorine with sodium hydroxide and hydrogen as co-products. The ethylene and chlorine are reacted to produce 1,2-dichloroethane (ethylene dichloride) (reaction 1). The 1,2-dichloroethane is then decomposed by heating in a high temperature furnace (cracking) when it produces vinyl chloride and hydrogen chloride (reaction 2). If the process were stopped at this stage, it is clear that 50% of the input of chlorine would be lost from the system and, unless there were a sufficient demand for hydrogen chloride, this would represent a significant loss of raw materials. In practice, however, the hydrogen chloride from reaction (2) is reacted with further ethylene in the presence of oxygen (a reaction known as oxychlorination), to produce further 1,2-dichloroethane (reaction 3). The dichloroethane is now decomposed according to reaction (2). By matching the direct and oxychlorination steps, the overall reaction adds reaction (1), (2) and (3). The chlorine is now completely used by the overall process. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1992-1993. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 10 polyvinyl chloride producers in Belgium, France, Germany, Italy, Sweden, UK. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	This data set covers all operations up to the production of the polymer resin from raw materials in the earth but excludes any subsequent processes such as compounding, which are carried out prior to conversion. The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste

	incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Data were supplied from 10 producers in Belgium, France, Germany, Italy, Sweden, UK. Their total production was 1,730,000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1992-1993
Data Type	Derived, mixed
Represents	
Method	European average data. Results are based on data supplied by 10 production plants in 6 countries: Belgium, France, Germany, Italy, Sweden and UK. Their total production was 1,730,000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports /htm/alphabetical.htm
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks''

	have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Air	217816.5943708709			mg	Air	Europe
	Input	Natural resource	Barytes	81.81679954580406			mg	Ground	Europe
	Input	Natural resource	Bauxite	443.6015361433576			mg	Ground	Europe
	Input	Natural resource	Bentonite	32.44535396792769			mg	Ground	Europe
	Input	Natural resource	Biomass	5953.3347692319			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	3.230132384390949			mg	Ground	Europe
	Input	Natural resource	Chalk	2.418299324869659E-014			mg	Ground	Europe
	Input	Natural resource	Clay	8.679560092704973			mg	Ground	Europe
	Input	Natural resource	Cr	3.841749308016037E-005			mg	Ground	Europe
	Input	Natural resource	Crude oil	400550.7579829833			mg	Ground	Europe
	Input	Natural resource	Dolomite	2.399063473004805			mg	Ground	Europe
	Input	Natural resource	Fe	237.3226510864353			mg	Ground	Europe
	Input	Natural resource	Feldspar	2.0335027918829E-020			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	.1762538245699166			mg	Ground	Europe
	Input	Natural resource	Fluorite	1.955896854116632			mg	Ground	Europe
	Input	Natural resource	Granite	3.918637634367406E-002			mg	Ground	Europe
	Input	Natural resource	Gravel	.7159611339362283			mg	Ground	Europe
	Input	Natural resource	Hard coal	141792.8477235998			mg	Ground	Europe
	Input	Natural resource	Hydro energy	.8956014309356798			MJ	Ground	Europe
	Input	Natural resource	Lignite	50578.71995896028			mg	Ground	Europe
	Input	Natural resource	Limestone	10372.6784717532			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	78.61360047701548			mg	Ground	Europe
	Input	Natural resource	Mg				mg	Ground	Europe
	Input	Natural resource	Natural gas	508005.2083990435			mg	Ground	Europe
	Input	Natural resource	Ni	1.285768104005235E-002			mg	Ground	Europe
	Input	Natural resource	Nitrogen	17004.36545501734			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	5.799485559066134			MJ	Ground	Europe
	Input	Natural resource	Olivine	1.82051180868594			mg	Ground	Europe
	Input	Natural resource	Oxygen	5549.819136814527			mg	Ground	Europe
	Input	Natural resource	Pb	.6561696427782844			mg	Ground	Europe
	Input	Natural resource	Peat	185.5325283246997			mg	Ground	Europe

	Input	Natural resource	Phosphate	1.089479464521626			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	5861.180663093755			mg	Ground	Europe
	Input	Natural resource	Rutile	3.471255124034486E-014			mg	Ground	Europe
	Input	Natural resource	Sand	469.3289876870805			mg	Ground	Europe
	Input	Natural resource	Shale oils	9.144504780210777			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	646752.566484388			mg	Ground	Europe
	Input	Natural resource	Sulphur	10294.35404632574			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	5141.174858423477			mg	Ground	Europe
	Input	Natural resource	Talc				mg	Ground	Europe
	Input	Natural resource	Water	72668277.04574353			mg	Water	Europe
	Input	Natural resource	Wood	101.0308862658268			mg	Ground	Europe
	Input	Natural resource	Zn	2.467197856847327E-002			mg	Ground	Europe
	Output	By-product	Recovered energy	-1.03161820824103			MJ	Technosphere	Europe
	Output	By-product	To incinerator	31.0741121004838			mg	Technosphere	Europe
	Output	By-product	To recycling	14.34864520791232			mg	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	2.396709170974274			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	342.5404240923619			mg	Air	Europe
	Output	Emission	Acid as H+	47.52037257700189			mg	Water	Europe
	Output	Emission	Al	.2797009548404845			mg	Water	Europe
	Output	Emission	Aldehydes	9.650171013377196E-003			mg	Air	Europe
	Output	Emission	As	8.823530964478594E-005			mg	Water	Europe
	Output	Emission	BOD5	85.31552596995195			mg	Water	Europe
	Output	Emission	Ca2+	47.08257909620156			mg	Water	Europe
	Output	Emission	CH4	7440.42494188185			mg	Air	Europe
	Output	Emission	Chloroorganics	.2620276479499495			mg	Water	Europe
	Output	Emission	Chloroorganics	36.80461810242601			mg	Air	Europe
	Output	Emission	Cl-	39249.93461225757			mg	Water	Europe
	Output	Emission	Cl2	1.677094233080803			mg	Air	Europe
	Output	Emission	Cl2	1.747436672758813			mg	Water	Europe
	Output	Emission	CN-	2.177616717896682E-002			mg	Water	Europe
	Output	Emission	CO	2250.686358562657			mg	Air	Europe
	Output	Emission	CO2	1950539.720751177			mg	Air	Europe
	Output	Emission	CO32-	62.83678038148311			mg	Water	Europe
	Output	Emission	COD	760.2244262857323			mg	Water	Europe
	Output	Emission	CrO3	4.622425637986934E-005			mg	Water	Europe
	Output	Emission	CS2	8.825239823559138E-005			mg	Air	Europe
	Output	Emission	Cu	1.005535531687719			mg	Water	Europe
	Output	Emission	Dissolved organics	1557.680144228078			mg	Water	Europe
	Output	Emission	Dissolved solids	2633.379379850142			mg	Water	Europe
	Output	Emission	F-	3.932437870065469E-003			mg	Water	Europe
	Output	Emission	F2	1.075041244299168E-004			mg	Air	Europe
	Output	Emission	Fe	4.52424243666768			mg	Water	Europe
	Output	Emission	H2	292.5289905470682			mg	Air	Europe
	Output	Emission	H2S	1.98173967012441			mg	Air	Europe
	Output	Emission	H2SO4	3.073969119129772E-005			mg	Air	Europe
	Output	Emission	Halogenated hydrocarbons (chlorofluoroca	.9531124627219505			mg	Air	Europe
	Output	Emission	HCl	150.1700794528082			mg	Air	Europe
	Output	Emission	HCN	1.186542483210084E-019			mg	Air	Europe
	Output	Emission	HF	3.898346045517278			mg	Air	Europe
	Output	Emission	Hg	.390926139636049			mg	Air	Europe
	Output	Emission	Hg	2.14765498395163E-002			mg	Water	Europe
	Output	Emission	K+	179.8289595252057			mg	Water	Europe
	Output	Emission	Metals	3.45193374095641			mg	Air	Europe
	Output	Emission	Metals	64.02911500896954			mg	Water	Europe

	Output	Emission	Mg	2.145626371311389			mg	Water	Europe
	Output	Emission	N total	1.667981111753061			mg	Water	Europe
	Output	Emission	N2O	.1489240370343741			mg	Air	Europe
	Output	Emission	Na	7820.427944397924			mg	Water	Europe
	Output	Emission	NH3	.3037404641172978			mg	Air	Europe
	Output	Emission	NH4+	3.598349865254633			mg	Water	Europe
	Output	Emission	Ni	.8573614144515537			mg	Water	Europe
	Output	Emission	NO3-	1.089600860926851			mg	Water	Europe
	Output	Emission	NOx	9507.036947793949			mg	Air	Europe
	Output	Emission	Oil	48.85264698705586			mg	Water	Europe
	Output	Emission	P2O5	16.71086857658295			mg	Water	Europe
	Output	Emission	PAH				mg	Air	Europe
	Output	Emission	Particles	2869.453389755976			mg	Air	Europe
	Output	Emission	Pb	2.59219148456583E-003			mg	Water	Europe
	Output	Emission	Pb	6.852535702544724E-005			mg	Air	Europe
	Output	Emission	Phenol	2.634421253063783			mg	Water	Europe
	Output	Emission	S2-	.9524046583463215			mg	Water	Europe
	Output	Emission	SO2	8200.999863515584			mg	Air	Europe
	Output	Emission	SO42-	4096.7309322397			mg	Water	Europe
	Output	Emission	Suspended solids	1746.229114258065			mg	Water	Europe
	Output	Emission	Thiols	2.524741461673168E-002			mg	Air	Europe
	Output	Emission	Vinyl chloride	1.263780272408			mg	Water	Europe
	Output	Emission	Vinyl chloride	236.7209096915525			mg	Air	Europe
	Output	Emission	VOC	1899.27829157603			mg	Air	Europe
	Output	Emission	VOC	25.59247356977085			mg	Water	Europe
	Output	Emission	VOC	3.106263062841659			mg	Water	Europe
	Output	Emission	VOC	5.534711319752028			mg	Air	Europe
	Output	Emission	VOC	72.0766746410408			mg	Air	Europe
	Output	Emission	Zn	4.103600778769533E-003			mg	Water	Europe
	Output	Product	PVC (s)	1			kg	Technosphere	Europe
	Output	Residue	Construction	16.16132611340031			mg	Ground	Europe
	Output	Residue	Industrial	4212.342467916129			mg	Ground	Europe
	Output	Residue	Inert chemical	11485.09784746424			mg	Ground	Europe
	Output	Residue	Metals	21.78920112774192			mg	Ground	Europe
	Output	Residue	Mineral	42294.19065221888			mg	Ground	Europe
	Output	Residue	Paper & board	1.232916342129509E-013			mg	Ground	Europe
	Output	Residue	Plastics	438.7260382509735			mg	Ground	Europe
	Output	Residue	Regulated chemical	5009.708783829864			mg	Ground	Europe
	Output	Residue	Slags & ashes	9367.010388754752			mg	Ground	Europe
	Output	Residue	Unspecified	8.795484981025329			mg	Ground	Europe
	Output	Residue	Wood waste	.9938463884812549			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PVC (s). ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. -- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products.

	Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .
Reviewer	-
Applicability	European average data. Data were supplied from 10 producers in Belgium, France, Germany, Italy, Sweden, UK. Their total production was 1,730,000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for PVC (s) production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of PVC (s) in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name

	Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

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SPINE LCI dataset: Production of pork. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Production of pork. ESA-DBP
Functional Unit	1kg of pork
Functional Unit Explanation	
Process Type	Gate to gate
Site	Swedish Meats, Örebro, Sweden
Sector	Crop and animal production, hunting etc.
Owner	Swedish Meats, Örebro, Sweden

Technical system description	Excerpt from the report, see 'Publication': ''The Swedish meat consumption is quite constant, about 25 kg beef and 36 kg pork per capita each year. Domestic production accounts for 58% (139 million kg) and 79% (295 million kg) of the beef and pork production respectively. The company participating in the study, Swedish Meats, is one of the biggest food companies in Sweden, producing 58% of the slaughtered meat consumed. The company offers slaughtering and refining of beef, lamb and pork. The production of meat affects the environment in many ways. As for eutrofication and acidification, the largest contributor is the handling of manure; either in storage or as fertiliser in agriculture. Here ammonia in the form of emissions from manure and nitrogen leakage from crop cultivation are the most important substances, for acidification and eutrofication respectively. The cultivation of crop for use as fodder in the animal production affects the environment in other ways also, as an example the production of 1 kg of pork requires 11 m2 of land, out of which 9 m2 in Europe and 1.5 m2 in South America, the latter mainly for soy cultivation. This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Pea-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Pea cultivation. ESA-DBP - Production of beef. ESA-DBP - Rape seed cultivation. ESA-DBP - Wheat cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean processing. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries

Nature Boundary	Data include use of energy, as well as emissions to air and water.
Time Boundary	The data come from the report which was completed in 2002.
Geographical Boundary	Excerpt from the report, see 'Publication': ''Most ingredients in the two animal-based products originate from Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': ''Not included are any aspects regarding personnel. (...) Some ingredients in the food processes have been judged to contribute very little to the overall process, and have therefore been excluded.''
Allocations	Excerpt from the report, see 'Publication': ''when allocation had to be used, an economic allocation approach was used''.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from other report.
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf The particular data come from: Ahlmén K. (2002) LCA livsmedel, Maten och Miljön: Livscykelanalys av sju livsmedel. Sigill Kvalitetssystem AB, Stokholm, Sweden
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-

	product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Avoided production of district heating from use of waste	Input	Refined resource	District heating	-8.80E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity	8.00+00			MJ	Technosphere	Sweden
	Input	Refined resource	Fossil fuel	1.93E+01			MJ	Technosphere	Sweden
	Input	Refined resource	Renewable energy source	2.80E-01			MJ	Technosphere	Sweden
	Output	Emission	CH4	4.00E+01			g	Air	Sweden
	Output	Emission	CO2	1.56E+03			g	Air	Sweden
	Output	Emission	N total	5.50E+01			g	Water	Sweden
	Output	Emission	N2O	6.30E+00			g	Air	Sweden
	Output	Emission	NH3	2.60E+01			g	Air	Sweden
	Output	Emission	NOx	8.60E+00			g	Air	Sweden
	Output	Emission	P Total	1.30E+00			g	Water	Sweden
	Output	Emission	SOx	4.20E+00			g	Air	Sweden
	Output	Product	Pork	1.00E+03			g	Other	Sweden

About Inventory

Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .
Practitioner	Anders Abelmann - Chalmers University of Technology.
Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The data for pork and beef used for a study were taken from a publication: Ahlmén K. (2002) LCA livsmedel, Maten och Miljön: Livscykelanalys av sju livsmedel. Sigill Kvalitetssystem AB, Stokholm, Sweden

SPINE LCI dataset: Production of powdered limestone

Administrative	
Finished	Y
Date Completed	1994
Copyright	
Availability	Public

Technical System	
Name	Production of powdered limestone
Functional Unit	1 kg
Functional Unit Explanation	1kg powdered limestone.
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Production of powdered limestone, includes mining and crushing..

System Boundaries	
Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	Energy consumption and waste are accounted for in the study.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1994
Data Type	Unspecified
Represents	See 'Function'
Method	The data are based on information from van Oosterbosch J, Forbo-Krommenie, Netherlands 1993-94, through personal communication.
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf The particular data come from: Ahlmén K. (2002) LCA livsmedel, Maten och Miljön: Livscykelanalys av sju livsmedel. Sigill Kvalitetssystem AB, Stokholm, Sweden
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data									
QMetaData	**Direction**	**FlowType**	**Substance**	**Quantity**	**Min**	**Max**	**Unit**	**Environment**	**Geography**
	Input	Refined resource	Electricity	0.08			MJ	Technosphere	
	Output	Product	Powdered limestone	1			kg	Technosphere	
	Output	Residue	Dust	72			g	Other	

About Inventory	
Publication	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994 -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Detailed Purpose	
Commissioner	
Practitioner	Jönsson Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden.
Reviewer	
Applicability	The data are based on old sources and should therefore not be regarded as information describing the current situation.
About Data	
Notes	

SPINE LCI dataset: Production of powdered wood

Administrative	
Finished	Y
Date Completed	1994
Copyright	
Availability	Public

Technical System	
Name	Production of powdered wood
Functional Unit	1 kg
Functional Unit Explanation	1kg powdered wood.
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Production of powdered wood, includes cultivating , grinding, felling and drying.

System Boundaries

Nature Boundary	Arable land-use is accounted for. No emissions for the combustion of fossil fuel are included
Time Boundary	
Geographical Boundary	
Other Boundaries	Energy consumption is accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	Unspecified
Represents	See 'Function'
Method	The data are based on information from Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994
Literature Reference	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Used at cultivating and grinding	Input	Refined resource	Electricity	3.2			MJ	Technosphere	
	Input	Refined resource	Forest land	5.9			m2	Agricultural ground	
Notes: Used at felling and drying. No emission factors are accounted for regarding the combustion of the fossil fuel.	Input	Refined resource	Fossil fuel	0.2			MJ	Technosphere	
	Output	Product	Powdered wood	1			kg	Technosphere	

About Inventory

Publication	Jönsson Å, Tillman A-M and Svensson T. Livscykelanalys av golvmaterial. (Life Cycle Assessment of flooring materials). Report R30:1994, Swedish Council for Building Research, Stockholm, 1994 -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	Exercise material in LCA coarse given at Technical Environmental Planning at Chalmers University of Technology, Sweden.
Detailed Purpose	

Commissioner	
Practitioner	Jönsson Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden.
Reviewer	
Applicability	The data should represent Coniferious trees grown in southern Germany, but because such data were not available data for Swedish pine are used as an approximation. Regards must be taken for that no emission factors for the combustion of fossil fuel are accounted for in the table.
About Data	
Notes	

SPINE LCI dataset: Production of primary copper

Administrative	
Finished	Y
Date Completed	1998
Copyright	The International Copper Association
Availability	Public

Technical System	
Name	Production of primary copper
Functional Unit	1 kg of pure copper
Functional Unit Explanation	The primary copper is leaving this system with 99.99% purity.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	Data received for this study are based on pyrometallurgical operations only. This activity includes: 1) Copper ore mining; 2) Copper ore concentrate preparation and delivery; 3) Production of matte copper; 4) Production of blister copper; 5) Production of copper anodes and 6) Production of primary copper. Production and use of electricity and fuel used in the processes are included. Below is a description of the included operations. -- 1) Ore mining -- The copper ore mining method used is determined by the size, shape and depth below the surface of the ore body. Most copper ores are mined by open pit mining in which large quarries are opened, the ore broken away from the deposits by use of explosives and shovelled into trucks. Actual energy requirements vary widely depending on the characteristics of the mine and ore handling techniques used. The type and the amount of ore deposit and the overlying rock and dirt and the depth of the seam below the surface, affect the level of energy needed for mining the ore. The data for copper mining have been received from three mining companies. The data cover the mining of 45 million tonnes of ore. -- 2) Ore concentrate preparation and delivery -- It is normal practice for mining companies to prepare or concentrate before shipping to reduce the amount of material to be transported. The data mainly relates to transportation of ore concentrate by rail and sea. Transporting the concentrate by sea is exstensive. It is assumed that average shipping and rail transport distances were 10 000 km and 500 km respectively. The data cover preparation of 2 million tonnes of concentrate

	-- 3) Production of matte copper -- Here the ore concentrate, mixed with flux and other additives, is charged in a fuelfired smelting furnace where it is melted. The molten mass is allowed to separate into two layers. The upper slag layer, made up of iron silicate with less than 0,5% of copper, is normally discarded. The lower matte layer, with about 40% to 75% of copper, and containing most of original metal present, is transferred to the converting step to produce blister copper. -- 4) Production of blister copper -- During the production of blister copper the matte is converted to blister in a converter by oxidation in two stages. In the first stage iron sulphide is oxidised and fluxed to form slag which may contain copper (1-5%). The converter slag is ususally recycled back to the smelting furnace. With all the iron removed, the remaining copper sulphide is further oxidised to blister copper. --5) Production of copper anodes -- The blister copper from the converter is transferred to anode furnace to reduce the residual sulphur as well as the oxygen levels in the metal. The data cover the production of 1 million tonnes of copper anodes. -- 6) Production of primary copper -- The metal at the anode stage still has some impurities (such as As, Bi, Ni, Pb and Sb) left along with precious metals (such as Ag, Au, Pt and Pd). These are separated from the copper by electro- refining into primary copper. The data covers the production of 900 000 tonnes of primary copper.

System Boundaries

Nature Boundary	Some of the data on air and water emissions was provided in a form which made it impractical to calculate emissions for unit mass of product output. For example, from an air emission value given in the units of mg/m3 of air, it is not possible to calculate the total emission unless the total volume of air is known and this is seldom measured in pactice.Therefor, where available, only emission values associated with the given amount of product made are used.
Time Boundary	The data comes from mining companies and producers of primary copper for the operations during the 12 month period in 1995 (information why the year 1995 was chosen is not available).
Geographical Boundary	The data comes mainly from European operations. Futher information of the geographical boundaries is not available.
Other Boundaries	The copper producing industry is international.
Allocations	The first thing that has been done to analyse this system is to break down the complex system into a series of separate sub-systems each of which produces a single product but which, when added together, exhibit the same charateristics as the original single system. In this study has co-product allocation and Stoichiometric allocation been applied. It is not often that practical processes exactly match for example the stoichiometric rules and an alternative method using mass must be applied.
Systems Expansions	Not applied

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, unspecified
Represents	See 'Function'
Method	An LCA calculation of primary copper production. The tables that have been used are the tables 70, 72, 73, 74 and 75 in the Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998. For the following subjects has a slightly different name been use here in SPINE compaired from the original tables in the IAC report: In SPINE: In the IAC report: Iron Ore Iron Natural Gas Gas/Condensate NaCl Sodium Chloride HC Hydrocarbons Cr Chromium CH4 Methane Cu Cu++/Cu+++ Na Na+ Calcium Ca++ NO3-N NO3- Hazardous waste Regulated chemical Other rest products Inert chemical
Literature Reference	Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998.
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Bauxite	31000			mg	Ground	
	Input	Natural resource	Bentonite	56			mg	Ground	
	Input	Natural resource	Calcium sulphate	700			mg	Ground	
Notes: This result covers Coal (1100000mg) and metalurgical coal (28 000 mg).	Input	Natural resource	Coal	1128000			mg	Ground	
	Input	Natural resource	Cr	130			mg	Ground	
	Input	Natural resource	Crude oil	240000			mg	Ground	
	Input	Natural resource	Dolomite	1800			mg	Ground	
	Input	Natural resource	Iron ore	76000			mg	Ground	
	Input	Natural resource	Lead	3			mg	Ground	
	Input	Natural resource	Lignite	33000			mg	Ground	
	Input	Natural resource	Limestone	130000			mg	Ground	
	Input	Natural resource	NaCl	7600			mg	Ground	
	Input	Natural resource	Natural gas	170000			mg	Ground	
	Input	Natural resource	Nitrogen	1100			mg	Ground	
Notes: Includes bonded and elemental sulphur.	Input	Natural resource	Sulphur	1030			mg	Ground	
	Input	Natural resource	Wood	300000			mg	Ground	
	Input	Natural resource	Zinc	3600			mg	Ground	
	Output	Emission	As	65			mg	Air	
	Output	Emission	BOD	1300			mg	Water	
	Output	Emission	Calcium	210			mg	Water	
	Output	Emission	Cd	7			mg	Air	
	Output	Emission	CH4	3600			mg	Air	
	Output	Emission	Cl	260000			mg	Water	
	Output	Emission	CO	6300			mg	Air	
	Output	Emission	CO2	4200000			mg	Air	
	Output	Emission	COD	1300			mg	Water	
	Output	Emission	Cu	12			mg	Water	
	Output	Emission	Cu	290			mg	Air	
	Output	Emission	HC	10			mg	Water	
	Output	Emission	HC	5500			mg	Air	
	Output	Emission	HCl	520			mg	Air	
	Output	Emission	HF	26			mg	Air	
	Output	Emission	Na+	19			mg	Water	
	Output	Emission	NH4	23			mg	Water	
	Output	Emission	NO3-N	92			mg	Water	
	Output	Emission	NOx	38000			mg	Air	
	Output	Emission	Pb	1500			mg	Air	
	Output	Emission	Pb	53			mg	Water	
	Output	Emission	Phenol	10			mg	Water	
	Output	Emission	SO4	100000			mg	Water	
	Output	Emission	SOx	360000			mg	Air	
	Output	Emission	Sulphur	3100			mg	Water	
	Output	Emission	Susp solids	23000			mg	Water	
	Output	Emission	Zn	190			mg	Air	
	Output	Product	Copper	1			kg	Technosphere	
	Output	Residue	Ashes	490000			mg	Technosphere	
	Output	Residue	Hazardous waste	26000			mg	Technosphere	

	Output	Residue	Industrial waste	6200			mg	Technosphere	
	Output	Residue	Mineral waste	160000000			mg	Technosphere	
	Output	Residue	Other rest products	440			mg	Technosphere	

About Inventory	
Publication	Ecoprofile of Primary Copper Production- A report for The International Copper Association By Dr. I. Boustead. 1998. -- Data documented by: Sofia Medin, Electrolux ESD Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose of this work was to produce life-cycle inventory data for the production of primary copper based on data submitted by members of the International Copper Association from their own operations.
Detailed Purpose	The aim is to provide ''cradle to gate'' data for the production of primary copper.
Commissioner	- The International Copper Association .
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	There is no recommendation of how to use the data from this report. This activity is a ''cradle to gate'' system for primary copper production. In the sequence of operations leading up to primary copper production there are six main stages involved. These are 1) Copper ore mining; 2) Copper ore concentrate preparation and delivery; 3) Production of matte copper; 4) Production of blister copper; 5) Production of copper anodes and 6) Production of primary copper. All six stages in the primary copper production have been described cumulatively in separate activities in the database.
About Data	The data used for electricity and fuel production in the calculations leading to the results reported comes from the reports of International Energy Agency. Data Assumptions: Data received from participating companies show sometime wide variation with respect to metal contents of ore and various intermediate products such as concentrates, gas dust and scrap. Therefor has the following assumptions been made: 1. Copper content in ore. Where actual data on copper content of the ore were available these were used. Otherwise the content was calculated on the basis of mass flow. 2. Copper content of matte according to published literature is between 40% to 75%. The assumption made, where the copper content in matte was not derived from mass flow, is therefor 60 %. 3.Average copper content of blister was assumed to be 98,5%, based on published litterature. 4. Average copper content of copper anode was assumed to be 99.5% based om published literature. 5.Where the amount of SO2 gas is shown as one of the output products, it is regarded as 100 % pure. 6. There is also some loss of copper during ore preperation and the smelting and recovery processes. The loss can be calculated from the mass flow if accurate contents of the input and output materials where known.Where this is not possible, the loss is assumed to be 1% at each step of the sequence of operations. It is further assumed that there is another 4% loss of copper during the operational steps from ore preperation to electro-refining, making the total loss of copper to 5%.
Notes	The results in the report of the Ecoprofile study has been broken down into a number of categories, identifying the type of operation that gives rise to them. The categories are: 1. Fuel production 2. Fuel use 3. Process 4. Transport 5. Biomass (inputs and outputs associated with the use of biological materials such as wood)

SPINE LCI dataset: Production of PVC

Administrative	
Finished	Y
Date Completed	1996-03-01
Copyright	
Availability	Public

Technical System	
Name	Production of PVC
Functional Unit	ton
Functional Unit Explanation	1 ton produced PVC together with the by-products. The company also sell some biproducts, that are made in the PVC production. For each ton of PVC the biproducts sold are - 4,92 ton Caustic soda (NaOH) - 0,0310 ton Hydrchloric acid (30% HCl) - 1,15 ton 1,2-dichlore ethan
Process Type	Gate to gate
Site	Hydro Plast AB 444 83 Stenungsund Sweden
Sector	Materials and components
Owner	Hydro Plast AB 444 83 Stenungsund Sweden
Technical system description	Hydro Plast AB manufactures the plastic raw material polyvinyl chloride (PVC). The production includes preparation of chlore, VCM and PVC. The plant also has a sewage treatment works with biological filter and a filter-press for dewatering of sludge. The company also sell some by-products, that are made in the PVC-production. For each ton of PVC the by-products sold are - 4,92 ton Caustic soda (NaOH) - 0,0310 ton Hydrchloric acid (30% HCl) - 1,15 ton 1,2-dichlore ethan. Emissions to air are caused by shut-downs of the combustion oven at the VCM-factory. Continuous emission from the PVC-factory origines from drying of PVC and different point suction fans in the process. The discontinuous emission from the PVC-factory origines from disruption of the combustion oven when recycling VCM.

System Boundaries	
Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data
General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified
Represents	See 'Function'
Method	Studying the Environmental report from Hydro Plast AB for 1995, The Board of County in Göteborg and Bohus Diffuse emissions Measurements of diffuse emissions to air from the plant as a hole has been done at 16 different places at the surrounding area of plant. A known volume of air has been pumped through a carbon tube, and then analyses has been done to measure the vinyl chloride, dichlore ethane, chloroform, carbon tetrachloride anad trichlore ethane contents with a gas cromatograph. Emitted amounts have then been calculated according to a model developed at the University of Uppsala. This so called fence model has during 1995 been modified from results given from measurements done at the hight of thirty meters. Recent measurements show that the mixing hight for gas is 44 meters.
Literature Reference	Eco- profiles of Primary Copper. A report for The International Copper Association, January 1998.
Notes	The emissions to air from the VCM-factory are caused by shut-downs of the combustion oven. The continuous emission from the PVC-factory origines from drying of PVC and different point suction fans in the process. The discontinuous emission from the PVC-factory origines from disruption of the combustion oven when recycling VCM. The method is mentioned on Specific QMetaData for a few emitted substances. The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geograp*
Date concieved: 1995 Data type: Unspecified Notes: Used in the chlore factory	Input	Refined resource	Activated carbon	0.006522625			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the chlore factory	Input	Refined resource	Carbon tetra chloride	0.012909363			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Aloxide, which is imprignated with copper cloride. Used in the VCM factory	Input	Refined resource	Catalyst	0.009036554			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the chlore factory.	Input	Refined resource	Cl	0.506515831			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Is used in the chlore factory	Input	Refined resource	CO2	0.000224555			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Mainly uswed in the chlore factory.	Input	Refined resource	Electricity	0.003478734			GWh	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the PVC factory	Input	Refined resource	Emulsifier	0.012236717			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the VCM factory	Input	Refined resource	Ethylene	0.671769262			tonne	Technosphere	
Data type: Unspecified	Input	Refined resource	Fuel gas	5.89075282			GJ	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: EO5 LS, < 0,4% S	Input	Refined resource	Fuel oil	0.088109798			GJ	Technosphere	

Date concieved: 1995 Data type: Unspecified Notes: Used in the chlore factory	Input	Refined resource	Graphite	0.00760973			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the chlore factory	Input	Refined resource	Hg	0.013588803			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the chlore factory	Input	Refined resource	Hydrazin	0.010871042			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Consist of 30% HCl. Used in the chlor factory.	Input	Refined resource	Hydrochloric acid	0.016136703			tonne	Technosphere	
Data type: Unspecified	Input	Refined resource	Hydrogen gas	2.528658785			GJ	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Is used in the PVC factory	Input	Refined resource	Initiation agents	0.002310096			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: This group includes the rest of the inorganic substances that is used that has not allready been shown in the table. Is used in the PVC factory (92,5%) and in the Chlore factory (7,50%).	Input	Refined resource	Inorganic substances	0.006081485			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the chlore factory (1,10%), the VCM factory (76,2%) and the PVC factory (22,7%).	Input	Refined resource	N	46.61390135			Nm3	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the VCM factory	Input	Refined resource	O2	0.841194456			Nm3	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: This group includes the rest of the organic substances that is used that has not allready been shown in the table. Is used in the PVC factory	Input	Refined resource	Organic substances	0.002704172			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used for cooling in the VCM fabric	Input	Refined resource	Propylene	0.023033021			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the chlore factory	Input	Refined resource	Sodium chloride	1.350557141			tonne	Technosphere	

Date concieved: 1995 Data type: Unspecified Notes: Used in the VCM factory. 74,9% in the form of tabletts.	Input	Refined resource	Sodium hydroxide	0.018242968			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Is used in the chlore factory	Input	Refined resource	Sulphuric acid	0.011027313			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the PVC factory	Input	Refined resource	Suspension agent	0.001644245			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Also includes gas rests from the processes	Input	Refined resource	Tar	0.96344612			GJ	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the VCM factory	Input	Refined resource	Vinyl chloride	0.283149884			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Used in the VCM factory.	Input	Refined resource	Zeolit	0.002473162			kg	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Is emitted continuous from the PVC factory.	Output	Emission	Ammonia	0.0000476			tonne	Air	
Data type: Unspecified	Output	Emission	Chlore ethyl alcohol	0.003213752			kg	Water	
Date concieved: 1995 Data type: Unspecified Method: The analyses have been done by Miljölaboratoriet in Nyköping and Hydro forskningscenter/ALTA Kalifornia. Notes: Emitted from the combustion plant.	Output	Emission	Chlorinated benzenes		0.004416361	0.012909363	g	Air	
Date concieved: 1995 Data type: Unspecified Method: The analyses have been done by Miljölaboratoriet in Nyköping and Hydro forskningscenter/ALTA Kalifornia. Notes: Emitted from the combustion plant.	Output	Emission	Chlorinated phenols		0.00067944	0.00135888	g	Air	
Date concieved: 1995 Data type: Unspecified Notes: A diffuse emission.	Output	Emission	Chloroform	0.0000598			tonne	Air	
Data type: Unspecified	Output	Emission	Chloroform	0.000794945			kg	Water	
Data type: Unspecified	Output	Emission	COD	0.001127871			tonne	Water	
Date concieved: 1995 Data type: Unspecified Notes: During the year the company has refilled the coolants with R12 2,60%, R22 58,4% and R502 39,0%.	Output	Emission	Coolant	0.000261584			tonne	Air	

Date concieved: 1995 Data type: Unspecified Notes: 1,2-dichlore ethane	Output	Emission	Dichlore ethane	0.0000611			kg	Water	
Date concieved: 1995 Data type: Modeled data Method: The dichlore ethan content in the air, when loading and shipping the substance, is measured to be 1 vol%. Given this, the annual amount has been calculated to 24 g. Notes: 20,7% of the 1,2-dichlore ethan is discontinuous emission from the the VCM-factory, 12,7% is discontinuous emission caused when loading the substance and the rest of the emission is diffuse.	Output	Emission	Dichlore ethane	0.000338361			tonne	Air	
Date concieved: 1995 Data type: Unspecified Notes: A discontinuous emission from the VCM-factory.	Output	Emission	Dichlore ethylene	0.00000408			tonne	Air	
Date concieved: 1995 Data type: Unspecified Notes: Emission from the combustion plant.	Output	Emission	Dust	0.0000353			tonne	Air	
Date concieved: 1995 Data type: Unspecified Notes: A discontinuous emission from the VCM-factory.	Output	Emission	Ethane	0.00000544			tonne	Air	
Data type: Unspecified	Output	Emission	Ethyl alcohol	0.00000951			tonne	Water	
Date concieved: 1995 Data type: Unspecified Notes: A discontinuous emission from the VCM-factory.	Output	Emission	Ethyl chloride	0.0000204			tonne	Air	
Data type: Unspecified	Output	Emission	Ethyl chloride	0.0000544			kg	Water	
Data type: Unspecified	Output	Emission	Hg	0.00000258			kg	Water	
Date concieved: 1995 Data type: Unspecified Notes: A continuous emission from the chlor factory.	Output	Emission	Hg	0.000149477			kg	Air	
Data type: Unspecified	Output	Emission	Isopropyl alcohol	0.0000258			tonne	Water	
Data type: Unspecified	Output	Emission	Methanol	0.0000353			tonne	Water	
Date concieved: 1995 Data type: Unspecified Notes: Hydrazin nitrogene measured as N2H4	Output	Emission	N2H4	0.00000679			tonne	Water	
Data type: Unspecified	Output	Emission	Natriumformiat	0.00016986			tonne	Water	

Date concieved: 1995 Data type: Unspecified Notes: Nitrogen from sewage treatment works measured as NH4.	Output	Emission	NH4	0.000271776			tonne	Water	
Date concieved: 1995 Data type: Unspecified Notes: Emission from combustion plant.	Output	Emission	NO2	0.000411741			tonne	Air	
Date concieved: 1995 Data type: Unspecified Method: The analyses have been done by Miljölaboratoriet in Nyköping and Hydro forskningscenter/ALTA Kalifornia. Notes: Emission from combustion plant.	Output	Emission	PCB	0	0.00000136	0.00000883	g	Air	
Date concieved: 1995 Data type: Unspecified Notes: Phosphorus measured as PO4.	Output	Emission	PO4	0.004144585			kg	Water	
Date concieved: 1995 Data type: Unspecified Notes: A discontinuous emission from the VCM-factory.	Output	Emission	Propylene	0.0000231			tonne	Air	
Date concieved: 1995 Data type: Estimated Method: The amount is calculated to be 0,2% of susp solids. This is based on analyses made after the PVC-recycling started in 1994.	Output	Emission	PVC	0.00016986			kg	Water	
Data type: Unspecified	Output	Emission	Sodium acetate	0.0000394			tonne	Water	
Date concieved: 1995 Data type: Unspecified Notes: Emission from combustion of fuel oil.	Output	Emission	Sulphur	0.00000815			tonne	Air	
Data type: Unspecified	Output	Emission	Susp solids	0.0000843			tonne	Water	
Date concieved: 1995 Data type: Unspecified Method: The analyses have been done by Miljölaboratoriet in Nyköping and Hydro forskningscenter/ALTA Kalifornia. Notes: TCDD (N-TEQ), emission from combustion plant.	Output	Emission	TCDD		0.000883272	0.001630656	mg	Air	
Date concieved: 1995 Data type: Unspecified Notes: 1,1,2-trichlore ethan	Output	Emission	Trichlore ethane	0.000319337			kg	Water	
Date concieved: 1995 Data type: Unspecified Notes: Is a diffuse emission from the PVC factory.	Output	Emission	Unspecified	0.00000218			tonne	Air	
Data type: Unspecified	Output	Emission	Vinyl chloride	0.0000679			kg	Water	

Date concieved: 1995 Data type: Unspecified Notes: The subatance is emitted - discontinuously from the VCM-factory (2,20%) - continuously from the PVC-factory (46,8%) - discontinuously from the PVC-factory (17,4%) - as diffuse emission (32,9%) - in the sewage treatment plant (0,643%)	Output	Emission	Vinyl chloride	0.00073991			tonne	Air	
Data type: Random samples Method: This is a coarse estimation, based on few measurements on the drying air from the different PVC departments. At the time of measuring only three out of fourteen types of PVC, manufactured during 1995, were in production. Notes: This group includes methanol, ethyl alcohol, iso propyl alcohol, ammonia and acetic acid that is emitted and has not already been shown in the table. VOC is emitted continuously from the PVC-factory.	Output	Emission	VOC	0.000475608			tonne	Air	
Data type: Unspecified Notes: Is sold.	Output	Product	Dichlore ethane	1.14687			tonne	Technosphere	
Data type: Unspecified Notes: (30% HCl) Is sold.	Output	Product	Hydrochloric acid	0.030962			tonne	Technosphere	
Data type: Unspecified Notes: Is sold.	Output	Product	NaOH	0.884291			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: The main product consist of pasta-PVC (31,0%) and suspension-PVC (69,0%).	Output	Product	PVC	1			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: The asbestos is dumped at Kläpp	Output	Residue	Asbestos	0.00000681086			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Disposed by Hydro Plast AB east of the chlore factory, later to be used as landfilling	Output	Residue	Biological sludge	0.000951696			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Packing and building waste. Is dumped at Kläpp.	Output	Residue	Building waste	0.031131947			m3	Technosphere	

Date concieved: 1995 Data type: Unspecified Notes: Used katalyst from the VCM-factory (2,5% CuCl2), are stored in plastic barrels. Hazardous for the environment.	Output	Residue	Catalyst waste	0.0000122372			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Disposed by Hydro Plast AB at Hjälmarevägen	Output	Residue	Chemical sludge	0.001222306			tonne	Technosphere	
Notes: Chlorated rubber from the chlore factory, is stored in plastic barrels. Hazardous for the environment.	Output	Residue	Chlorated rubber	0.163095312			l	Technosphere	
Date concieved: 1995 Data type: Unspecified, expert outspoke Notes: ''Cyclohexanon'' waste, disposed at RECI in Värnamo	Output	Residue	Cyclohexanon waste	0.0051			l	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: The empty barrols are sent to Kungälvs fatrenovering (for renovating the barrols)	Output	Residue	Empty barrels	0.008620465			pce	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: The fluorescent lamps are sent to Sellbergs Väst.	Output	Residue	Fluorescent lamp	0.013597228			pce	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: 23,0% Heavy ends, stored in tanks. 77,0% Heavy ends, exported to Akzon the Netherlands for recycling of chlore Hazardous for the environment.	Output	Residue	Heavy ends	0.00869845			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Dumped at Kläpp.	Output	Residue	Household waste	0.000781356			m3	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: General laboratory waste from technical service, disposed by SAKAB. Hazardous for the environment.	Output	Residue	Laboratory waste	0.0000051			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: waste from lab analysis, disposed by SAKAB	Output	Residue	Laboratory waste	0.000126			l	Technosphere	

Date concieved: 1995 Data type: Unspecified Notes: Are stored in tanks. Hazardous for the environment.	Output	Residue	Light ends	0.009528975			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: 37,4% PVC waste from the PVC production and 62,6% PVC waste from sewage treatment plant	Output	Residue	PVC waste	0.0000544261			tonne	Technosphere	
Notes: The absorption agent (Safesorb), dumped at Kläpp	Output	Residue	Safesorb	0.0000101859			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: recycled at Stena Metall in Uddevalla	Output	Residue	Scrap	0.000802709			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: 0,459% Sludge, containing Hg, from the chlore factory 99,5% Sludge, containing Hg (activated carbon etc), from the chlore factory; stored in plastic barrols. Hazardous for the environment.	Output	Residue	Sludge containing Hg	0.001833575			tonne	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: disposed at Stena Miljö	Output	Residue	Waste fixing	0.000544			l	Technosphere	
Date concieved: 1995 Data type: Unspecified Notes: Paper and corrugated cardboard, recycled by IL Returpapper AB Göteborg	Output	Residue	Waste paper	0.003533089			m3	Technosphere	
Date concieved: 1995 Data type: Unspecified	Output	Residue	Waste water	5.511108846			m3	Water	

About Inventory

Publication	Environmental report from Hydro Plast AB for 1995, The Board of County in Göteborg and Bohus -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden.
Practitioner	Andersson, Sam - Hydro Plast AB 444 83 Stenungsund Sweden.
Reviewer	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden

Applicability	The function of the technical system is not sufficently described. Contact the company to get the necessary details.
About Data	According to the numbering of the pages in the environmental report, two pages are missing. These two pagaes may contain information about used chemicals and/or hazardous waste. Contact the company for futher information.
Notes	The annual inspection of the plant is made by ÅF-IPK (Box 1551, 401 51 Göteborg, Sweden, Phone +46 -31 7431191, Fax +46 -31 7431191).

SPINE LCI dataset: Production of PVC calendered sheet (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of PVC calendered sheet (APME)
Functional Unit	1 kg PVC calendered sheet
Functional Unit Explanation	A calender is a set of three or more heated rolls which convert high viscosity polymer resin into sheet. The sheet, in this case, is 300 mm made from PVC.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. The main groups of operations covered in the study are the production of the polymer resin, the transport of the resin to the converter, the conversion process itself and the packaging of the finished component for onward dispatch. Also, the production of fuels and energy used in the processes and transports are included. Polymer resins are delivered to converters either in bulk tankers or in plastic sacks. In this case it is assumed that all resin is delivered by bulk tanker, 20 tonne. The delivery distance is assumed to be 100 km one way. The bulk tanker must make an empty return and the fuel consumtion of an empty tanker is assumed to be 70% of that of a fully laden vehicle. Data for the conversion process have been obtained by four different factories operating in Germany, which produce 300 mm calendered PVC sheet. The data supplied covers all operations starting with PVC resin, and following all operations through mixing, preplastifying, calendering, pulling, cooling rolls, wind-up and packaging. All internal transport is also included. Polymer used in calendered sheet production contains 2.5-5% of additives (stabilisers, polymeric modifiers, slip agents and pigments). However, in this study these have all been treated as if they were OVC homopolymer. The conversion process: A calender is a set of three or more heated rolls which convert high viscosity polymer into sheet. The polymer passes between a sequence of heated rolls which control the feed rate, the thickness of the sheet and the surface finish. The polymer compound is, usually preheated, is fed through a pair of mixing rolls to ensure a uniform consistency. The polymer compound passes through a metal separation device to remove any accidental contamination before passing the calender itself. Once formed, the sheet is fed to cooling rolls and after passing through a thichness measurement operation is trimmed before being wound onto the final rolls. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow

	with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	The study take no account of any air emissions arising directly from the conversion process. While it is impossible to carry out such a process without generating some emissions, the quantities involved are thought to be very small and not significant compared with the burdens imported with the inputs to the system. ''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data supplied by 4 producers of PVC calendered sheet in Germany. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	In practice the polymer used in calendered sheet production contains 2.5% to 5.0% additives. In this case the polymer is treated as if they were PVC homopolymer. The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Data were supplied from 4 PVC calendered sheet producers Germany. Their total production was not known, since the data supplied was normalized.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce

	concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, mixed
Represents	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New name: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.
Method	European average data. Results are based on data supplied by 4 PVC celendered sheet production plants. The data was supplied as normalized data, therefore the production volume is not known. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emissions. For fuels and feedstock materials, actual gross calorific values (energy conten) have been used in teh calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened ind imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports /htm/alphabetical.htm
Notes	The emissions to air from the VCM-factory are caused by shut-downs of the combustion oven. The continuous emission from the PVC-factory origines from drying of PVC and different point suction fans in the process. The discontinuous emission from the PVC-factory origines from disruption of the combustion oven when recycling VCM. The method is mentioned on Specific QMetaData for a few emitted substances. The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Air	219068.7256			mg	Air	Europe
	Input	Natural resource	Barytes	82.29996355			mg	Ground	Europe
	Input	Natural resource	Bauxite	449.6919533			mg	Ground	Europe
	Input	Natural resource	Bentonite	33.16432802			mg	Ground	Europe
	Input	Natural resource	Biomass	7248.453996			mg	Ground	Europe
	Input	Natural resource	Calcium fluoride	2.057626719			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	3.249219476			mg	Ground	Europe
	Input	Natural resource	Chalk	3.28E-14			mg	Ground	Europe
	Input	Natural resource	Chromium in ore	1.050740711			mg	Ground	Europe
	Input	Natural resource	Clay	8.755781112			mg	Ground	Europe
	Input	Natural resource	Crude oil	423390.5544			mg	Ground	Europe
	Input	Natural resource	Dolomite	11.09448827			mg	Ground	Europe
	Input	Natural resource	Feldspar	2.76E-20			mg	Ground	Europe
	Input	Natural resource	Ferromanganese in ore	0.823422161			mg	Ground	Europe
	Input	Natural resource	Granite	4.72E-02			mg	Ground	Europe
	Input	Natural resource	Gravel	3.341115577			mg	Ground	Europe
	Input	Natural resource	Hard coal	209072.608			mg	Ground	Europe
	Input	Natural resource	Hydro energy	1.06E+00			MJ	Ground	Europe
	Input	Natural resource	Iron in ore	949.3885597			mg	Ground	Europe
	Input	Natural resource	Lead in ore	2.865230675			mg	Ground	Europe

	Input	Natural resource	Lignite	156487.4221			mg	Ground	Europe
	Input	Natural resource	Limestone	10698.69919			mg	Ground	Europe
	Input	Natural resource	Magnesium	0			mg	Ground	Europe
	Input	Natural resource	Natural gas	532391.5002			mg	Ground	Europe
	Input	Natural resource	Nickel in ore	1.29E-02			mg	Ground	Europe
	Input	Natural resource	Nitrogen	17133.60355			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	7.756694432			MJ	Ground	Europe
	Input	Natural resource	Olivine	8.495629264			mg	Ground	Europe
	Input	Natural resource	Oxygen	5601.60881			mg	Ground	Europe
	Input	Natural resource	Peat	198.8832488			mg	Ground	Europe
	Input	Natural resource	Phosphate	1.310884233			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	5881.154805			mg	Ground	Europe
	Input	Natural resource	Rutile	4.71E-14			mg	Ground	Europe
	Input	Natural resource	Sand	478.6090725			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	649009.7702			mg	Ground	Europe
	Input	Natural resource	Sulphur in ore	15492.81941			mg	Ground	Europe
	Input	Natural resource	Talc	0			mg	Ground	Europe
	Input	Natural resource	Water, cooling	81468268			mg	Water	Europe
	Input	Natural resource	Water, process	11998029			mg	Water	Europe
	Input	Natural resource	Wood	98544.10771			mg	Ground	Europe
	Input	Natural resource	Zinc in ore	0.107732673			mg	Ground	Europe
	Output	By-product	Recovered energy	1.005410846			MJ	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	2.404857982			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	343.7050616			mg	Air	Europe
	Output	Emission	Acid as H+	48.57468584			mg	Water	Europe
	Output	Emission	Al3+	0.292159932			mg	Water	Europe
	Output	Emission	Aldehydes	1.16E-02			mg	Air	Europe
	Output	Emission	As	8.96E-05			mg	Water	Europe
	Output	Emission	BOD	102.1874831			mg	Water	Europe
	Output	Emission	Ca2+	47.48207523			mg	Water	Europe
	Output	Emission	CFCs	0.957481246			mg	Air	Europe
	Output	Emission	Chloroorganics	0.262937844			mg	Water	Europe
	Output	Emission	Chloroorganics	36.93390598			mg	Air	Europe
	Output	Emission	Cl-	39468.48518			mg	Water	Europe
	Output	Emission	Cl2	1.682879999			mg	Air	Europe
	Output	Emission	Cl2	1.753385307			mg	Water	Europe
	Output	Emission	CN-	2.20E-02			mg	Water	Europe
	Output	Emission	CO	2767.949709			mg	Air	Europe
	Output	Emission	CO2	2366700.801			mg	Air	Europe
	Output	Emission	CO32-	63.13540506			mg	Water	Europe
	Output	Emission	COD	924.6054456			mg	Water	Europe
	Output	Emission	CrO3	4.64E-05			mg	Water	Europe
	Output	Emission	CS2	8.87E-05			mg	Air	Europe
	Output	Emission	Cu	1.049471024			mg	Water	Europe
	Output	Emission	Dissolved organics	1563.038596			mg	Water	Europe
	Output	Emission	Dissolved solids	2644.631107			mg	Water	Europe
	Output	Emission	Dust	4932.268497			mg	Air	Europe
	Output	Emission	F-	6.81E-03			mg	Water	Europe
	Output	Emission	F2	1.60E-04			mg	Air	Europe
	Output	Emission	Fe	4.659846938			mg	Water	Europe
	Output	Emission	H2	346.6133476			mg	Air	Europe
	Output	Emission	H2S	2.808012027			mg	Air	Europe
	Output	Emission	H2SO4	3.16E-05			mg	Air	Europe
	Output	Emission	HCl	239.4447589			mg	Air	Europe
	Output	Emission	HCN	1.61E-19			mg	Air	Europe
	Output	Emission	HF	8.340770854			mg	Air	Europe
	Output	Emission	Hg	0.397763609			mg	Air	Europe
	Output	Emission	Hg	2.16E-02			mg	Water	Europe
	Output	Emission	K+	180.4417273			mg	Water	Europe
	Output	Emission	Metals	3.913839126			mg	Air	Europe
	Output	Emission	Metals	66.36833979			mg	Water	Europe
	Output	Emission	Methane	8365.713116			mg	Air	Europe
	Output	Emission	Mg2+	2.183831139			mg	Water	Europe
	Output	Emission	N total	4.009399747			mg	Water	Europe
	Output	Emission	N2O	0.17088955			mg	Air	Europe

	Output	Emission	Na+	7886.489757			mg	Water	Europe
	Output	Emission	NH3	0.305501488			mg	Air	Europe
	Output	Emission	NH4+	4.142901016			mg	Water	Europe
	Output	Emission	Ni	0.900759426			mg	Water	Europe
	Output	Emission	NO3-	1.236390874			mg	Water	Europe
	Output	Emission	NOx	11119.62736			mg	Air	Europe
	Output	Emission	Oil	49.54206569			mg	Water	Europe
	Output	Emission	P2O5	17.14741942			mg	Water	Europe
	Output	Emission	PAH	72.38194425			mg	Air	Europe
	Output	Emission	Pb	3.01E-04			mg	Air	Europe
	Output	Emission	Pb	3.06E-03			mg	Water	Europe
	Output	Emission	Phenol	3.458976764			mg	Water	Europe
	Output	Emission	S2-	1.060813126			mg	Water	Europe
	Output	Emission	SO2	10751.25794			mg	Air	Europe
	Output	Emission	SO42-	4111.590405			mg	Water	Europe
	Output	Emission	Suspended solids	1882.840688			mg	Water	Europe
	Output	Emission	Thiols	0.257192807			mg	Air	Europe
	Output	Emission	Vinyl chloride	1.268077125			mg	Water	Europe
	Output	Emission	Vinyl chloride	238.0757608			mg	Air	Europe
	Output	Emission	VOC	2229.770564			mg	Air	Europe
	Output	Emission	VOC	27.26963377			mg	Water	Europe
	Output	Emission	VOC	3.194753576			mg	Water	Europe
	Output	Emission	Zn2+	4.25E-03			mg	Water	Europe
	Output	Product	PVC calendered sheet	1			kg	Technosphere	Europe
	Output	Residue	Construction	16.23643209			mg	Ground	Europe
	Output	Residue	Industrial	4399.773588			mg	Ground	Europe
	Output	Residue	Inert chemicals	11545.461			mg	Ground	Europe
	Output	Residue	Metals	486.3611602			mg	Ground	Europe
	Output	Residue	Mineral	73351.34409			mg	Ground	Europe
	Output	Residue	Paper	11038.38222			mg	Ground	Europe
	Output	Residue	Plastics	462.3750932			mg	Ground	Europe
	Output	Residue	Regulated chemicals	5069.723198			mg	Ground	Europe
	Output	Residue	Slags & ashes	18087.9443			mg	Ground	Europe
	Output	Residue	To incinerator	31.40377936			mg	Technosphere	Europe
	Output	Residue	To recycling	14.4393257			mg	Technosphere	Europe
	Output	Residue	Unspecified	9632.796062			mg	Ground	Europe
	Output	Residue	Wood waste	362.264815			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PVC calendered sheet. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME´s web site http://lca.apme.org. -- Documented by Sofia Boström, Volvo Technological Development Corporation Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 24 May 2002 --
Intended User	1. LCA practitioners in genera
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from production of the polymer resin to the finished PVC sheet.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of PVC clendered sheets, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: -Plastic waste management stidues - Internal company benchmarking - Product development. Detailed environmental information to customers of APME memebers for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral.

	The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-1993, the period to which the oldest group of Eco-profiles data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - .
Practitioner	Ian Boustedt - .
Reviewer	
Applicability	European average data. Data were supplied from 4 PVC calendered sheet producers in Germany. Their total production was not known, since the data supplied was normalized. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for PVC calendered sheet production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of PVC calendered sheet in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO_2 emission. CO_2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO_2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin

	Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

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SPINE LCI dataset: Production of PVC injection moulding (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of PVC injection moulding (APME)
Functional Unit	1 kg saleable PVC mouldings
Functional Unit Explanation	Injection moulding is one of the most widely used polymer conversion processes, and is capable of producing almost any component. In this case, PVC is the polymer resin used as rawmaterial.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is aqcuired. The main groups of operations covered in the study are the production of the polymer resin, the transport of the resin to the converter, the conversion process itself and the packaging of the finished component for onward dispatch. Also, the production of fuels and energy used in the processes and transports are included.

	Polymer resins are delivered to converters either in bulk tankers or in plastic sacks. In this case it is assumed that all resin is delivered by bulk tanker, 20 tonne. The delivery distance is assumed to be 100 km one way. The bulk tanker must make an empty return and the fuel consumtion of an ampty tanker is assumed to be 70% of that of a fully laden vehicle. Data for the conversion process have been obtained by two factories in France which between them produces over 9000 tonne of PVC fittings for drainage pipe systems. The data includes all operations associated with compounding, injection moulding, storage, warehousing, heating and internal transport. Fillers, stabilisers, lubricants and pigments have been treated as if they were PVC homopolymer. The data also include in-house scrap which is ground and reused. On average the process produces 0.7% unusable polymer waste but all other scrap is recycled internally. There is, in addition, a small production of landfilled other waste (2.8 g per kg product) and some regulated waste (0.1 g per kg product). Water emissions are monitored and show a COD of 28 mg per kg product and suspended solids of 20 mg per kg product. These have been included in the calculations. The conversion process: Injection moulding is one of the most widely used polymer conversion processes and is capable of producing almost any component. In injection moulding, the polymer resin together with any additives are heated until molten and injected into a water sooled mould. Once solid, the mould is opened and the component ejected. The cycle is then repeated.Irrespective of the type of machinery used, the sequence of events in the injection moulding process can be represented as a time cycle. The four elements of the cycle are: 1) Injection time - the time taken to fill the mould with the molten polymer. 2) Dwell time - the time period during which the mould is full but remains under pressure. 3) Freeze time - the time required for the moulding to set sufficiently to allow the moulding to be removed without damage. 4) Dead time - the time required for the mould to open, for moulding to be removed and for the mould to close again. For raw materials, inputs as listed from APME, have been reocorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	The study take no account of any air emissions arising directly from the conversion process. While it is impossible to carry out such a process without generating some emissions, the quantities involved are thought to be very small and not significant compared with the burdens imported with the inputs to the system. ''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older. The total produciton was 9 000 tonnes.
Geographical Boundary	European indicative values. Results are based on data supplied by 2 producers of PVC mouldings in France. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	Fillers, lubricants, stabilisers and pigments have all been treated as if they were homopolymers. The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included).

	- Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. Results are based on data supplied by 2 PVC injection moulding production plants in France. Their total production was 9000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, mixed
Represents	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New name: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.
Method	European average data. Results are based on data supplied by 2 PVC injection moulding production plants in France. Their total production wasn 9000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied whereever there have been sufficient data from upstream raw material and fuel producers. In verticall averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the caluclations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO_2 emissions. For fuels and feedstock materials, actual gross calorific values (energy conten) have been used in teh calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened ind imported into Microsoft Excel.

	Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports/htm/alphabetical.htm
Notes	The emissions to air from the VCM-factory are caused by shut-downs of the combustion oven. The continuous emission from the PVC-factory origines from drying of PVC and different point suction fans in the process. The discontinuous emission from the PVC-factory origines from disruption of the combustion oven when recycling VCM. The method is mentioned on Specific QMetaData for a few emitted substances. The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Air	220223.7421			mg	Air	Europe
	Input	Natural resource	Barytes	82.63211239			mg	Ground	Europe
	Input	Natural resource	Bauxite	459.9580093			mg	Ground	Europe
	Input	Natural resource	Bentonite	34.50278064			mg	Ground	Europe
	Input	Natural resource	Biomass	24227.06223			mg	Ground	Europe
	Input	Natural resource	Calcium fluoride	2.15495879			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	3.253066324			mg	Ground	Europe
	Input	Natural resource	Chalk	3.29E-14			mg	Ground	Europe
	Input	Natural resource	Chromium in ore	4.850619469			mg	Ground	Europe
	Input	Natural resource	Clay	69.22133583			mg	Ground	Europe
	Input	Natural resource	Crude oil	697020.6357			mg	Ground	Europe
	Input	Natural resource	Dolomite	32.49572191			mg	Ground	Europe
	Input	Natural resource	Feldspar	2.77E-20			mg	Ground	Europe
	Input	Natural resource	Ferromanganese in ore	2.418509157			mg	Ground	Europe
	Input	Natural resource	Granite	3.95E-02			mg	Ground	Europe
	Input	Natural resource	Gravel	9.803222888			mg	Ground	Europe
	Input	Natural resource	Hard coal	209687.7862			mg	Ground	Europe
	Input	Natural resource	Hydro energy	2.12E+00			MJ	Ground	Europe
	Input	Natural resource	Iron in ore	2702.692336			mg	Ground	Europe
	Input	Natural resource	Lead in ore	3.594665274			mg	Ground	Europe
	Input	Natural resource	Lignite	57040.54941			mg	Ground	Europe
	Input	Natural resource	Limestone	11285.253			mg	Ground	Europe
	Input	Natural resource	Magnesium	0			mg	Ground	Europe
	Input	Natural resource	Natural gas	538257.1399			mg	Ground	Europe
	Input	Natural resource	Nickel in ore	1.29E-02			mg	Ground	Europe
	Input	Natural resource	Nitrogen	17160.535			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	20.01980103			MJ	Ground	Europe
	Input	Natural resource	Olivine	24.92716739			mg	Ground	Europe
	Input	Natural resource	Oxygen	5632.172395			mg	Ground	Europe
	Input	Natural resource	Peat	268.2534243			mg	Ground	Europe
	Input	Natural resource	Phosphate	1.097214766			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	5902.795046			mg	Ground	Europe
	Input	Natural resource	Rutile	4.72E-14			mg	Ground	Europe
	Input	Natural resource	Sand	473.3455498			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	651453.3156			mg	Ground	Europe
	Input	Natural resource	Sulphur in ore	15558.52398			mg	Ground	Europe
	Input	Natural resource	Talc	0			mg	Ground	Europe
	Input	Natural resource	Water, cooling	84627856			mg	Water	Europe
	Input	Natural resource	Water, process	23969414			mg	Water	Europe
	Input	Natural resource	Wood	1002080.211			mg	Ground	Europe
	Input	Natural resource	Zinc in ore	0.135159414			mg	Ground	Europe
	Output	By-product	Recovered energy	1.038997145			MJ	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	2.413725806			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	344.9724611			mg	Air	Europe
	Output	Emission	Acid as H+	49.04000547			mg	Water	Europe
	Output	Emission	Al3+	0.281686832			mg	Water	Europe
	Output	Emission	Aldehydes	9.72E-03			mg	Air	Europe
	Output	Emission	As	8.89E-05			mg	Water	Europe
	Output	Emission	BOD	303.7191469			mg	Water	Europe
	Output	Emission	Ca2+	47.41686541			mg	Water	Europe
	Output	Emission	CFCs	0.959879561			mg	Air	Europe
	Output	Emission	Chloroorganics	0.263899932			mg	Water	Europe
	Output	Emission	Chloroorganics	37.07005897			mg	Air	Europe
	Output	Emission	Cl-	39530.95143			mg	Water	Europe

	Output	Emission	Cl2	1.689046096			mg	Air	Europe
	Output	Emission	Cl2	1.759843473			mg	Water	Europe
	Output	Emission	CN-	2.22E-02			mg	Water	Europe
	Output	Emission	CO	3500.028455			mg	Air	Europe
	Output	Emission	CO2	1926482.453			mg	Air	Europe
	Output	Emission	CO32-	63.28292152			mg	Water	Europe
	Output	Emission	COD	2915.555778			mg	Water	Europe
	Output	Emission	CrO3	4.66E-05			mg	Water	Europe
	Output	Emission	CS2	8.89E-05			mg	Air	Europe
	Output	Emission	Cu	1.012674834			mg	Water	Europe
	Output	Emission	Dissolved organics	1568.954785			mg	Water	Europe
	Output	Emission	Dissolved solids	2656.57977			mg	Water	Europe
	Output	Emission	Dust	4349.025564			mg	Air	Europe
	Output	Emission	F-	1.26E-02			mg	Water	Europe
	Output	Emission	F2	2.51E-04			mg	Air	Europe
	Output	Emission	Fe	4.610622722			mg	Water	Europe
	Output	Emission	H2	294.6059464			mg	Air	Europe
	Output	Emission	H2S	12.72223484			mg	Air	Europe
	Output	Emission	H2SO4	3.10E-05			mg	Air	Europe
	Output	Emission	HCl	190.2815747			mg	Air	Europe
	Output	Emission	HCN	1.61E-19			mg	Air	Europe
	Output	Emission	HF	6.121576753			mg	Air	Europe
	Output	Emission	Hg	0.393701715			mg	Air	Europe
	Output	Emission	Hg	2.16E-02			mg	Water	Europe
	Output	Emission	K+	181.1057451			mg	Water	Europe
	Output	Emission	Metals	6.210357299			mg	Air	Europe
	Output	Emission	Metals	79.11344844			mg	Water	Europe
	Output	Emission	Methane	8678.484816			mg	Air	Europe
	Output	Emission	Mg2+	2.160860319			mg	Water	Europe
	Output	Emission	N total	32.55255045			mg	Water	Europe
	Output	Emission	N2O	0.149981398			mg	Air	Europe
	Output	Emission	Na+	7876.294343			mg	Water	Europe
	Output	Emission	NH3	0.305897114			mg	Air	Europe
	Output	Emission	NH4+	4.2183485			mg	Water	Europe
	Output	Emission	Ni	0.86344868			mg	Water	Europe
	Output	Emission	NO3-	1.452359714			mg	Water	Europe
	Output	Emission	NOx	13385.70525			mg	Air	Europe
	Output	Emission	Oil	51.63384647			mg	Water	Europe
	Output	Emission	P2O5	20.28756613			mg	Water	Europe
	Output	Emission	PAH	79.23421691			mg	Air	Europe
	Output	Emission	Pb	4.13E-03			mg	Water	Europe
	Output	Emission	Pb	8.70E-04			mg	Air	Europe
	Output	Emission	Phenol	14.54177962			mg	Water	Europe
	Output	Emission	S2-	2.289031369			mg	Water	Europe
	Output	Emission	SO2	15655.15157			mg	Air	Europe
	Output	Emission	SO42-	4125.884545			mg	Water	Europe
	Output	Emission	Suspended solids	2453.053674			mg	Water	Europe
	Output	Emission	Thiols	3.130598627			mg	Air	Europe
	Output	Emission	Vinyl chloride	1.272753112			mg	Water	Europe
	Output	Emission	Vinyl chloride	238.4016282			mg	Air	Europe
	Output	Emission	VOC	3.257887085			mg	Water	Europe
	Output	Emission	VOC	3282.825364			mg	Air	Europe
	Output	Emission	VOC	68.16109881			mg	Water	Europe
	Output	Emission	Zn2+	4.13E-03			mg	Water	Europe
	Output	Product	Injection moulded PVC	1			kg	Technosphere	Europe
	Output	Residue	Construction	1.63E+01			mg	Ground	Europe
	Output	Residue	Industrial	5512.564378			mg	Ground	Europe
	Output	Residue	Inert chemicals	14395.43258			mg	Ground	Europe
	Output	Residue	Metals	2148.086088			mg	Ground	Europe
	Output	Residue	Mineral	58074.69001			mg	Ground	Europe
	Output	Residue	Paper	1.48E+05			mg	Ground	Europe
	Output	Residue	Plastics	8159.430937			mg	Ground	Europe
	Output	Residue	Regulated chemicals	5146.286323			mg	Ground	Europe
	Output	Residue	Slags & ashes	15735.31955			mg	Ground	Europe
	Output	Residue	To incinerator	31.2947383			mg	Technosphere	Europe

	Output	Residue	To recycling	14.45052059			mg	Technosphere	Europe
	Output	Residue	Unspecified	44437.17565			mg	Ground	Europe
	Output	Residue	Wood waste	1.68E+03			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PVC moulding. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME´s web site http://lca.apme.org. Documented by Sofia Boström, Volvo Technological Development Corporation
Intended User	1. LCA practioners in general
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from production of the polymer resin to the finished PVC moulding.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of PVC mouldings, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: -Plastic waste management stidues - Internal company benchmarking - Product development. Detailed environmental information to customers of APME memebers for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-1993, the period to which the oldest group of Eco-profiles data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - .
Practitioner	Ian Boustedt - .
Reviewer	
Applicability	This data set provides indicative values for PVC injection moulding in Europe. It is important to recognise that the performance of injection moulding factories can be very variable because of factors such as rate of injection (kg/hour) , the design and age of the moulding machines, the general level of activity in the factory and the duration of a production sequence. As a consequence it is almost impossible to produce typical, representative figures for performance. Data were supplied by 2 PVC injection moulding producers in France. Their total production was 9000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European indicative values for PVC injection moulding production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. The reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data

	have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

SPINE LCI dataset: Production of PVC pipe (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of PVC pipe (APME)
Functional Unit	1 kg extruded PVC pipe
Functional Unit Explanation	In pipe extrusion the molten polymer is extruded through an annular die and cooled by passing through a water trough. The polymer used as raw material is in this case PVC.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is aqcuired. The main groups of operations covered in the study are the production of the polymer resin, the transport of the resin to the converter, the conversion process itself and the packaging of the finished component for onward dispatch. Also, the production of fuels and energy used in the processes and transports are included. Polymer resins are delivered to converters either in bulk tankers or in plastic sacks. In this case it is assumed that all resin is delivered by bulk tanker, 20 tonne. The delivery distance is assumed to be 100 km one way. The bulk tanker must make an empty return and the fuel consumtion of an ampty tanker is assumed to be 70% of that of a fully laden vehicle. In pipe extrusion the molten polymer is extruded through an annular die and cooled by passing through a water trough. Data for the conversion process have been obtained by three factories operating in the Netherlands. The effects of stabilisers have been ignored so that in the calculations all of the weight of the pipe is assumed to be PVC homopolymer. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries	
Nature Boundary	The study take no account of any air emissions arising directly from the conversion process. While it is impossible to carry out such a process without generating some emissions, the quantities involved are thought to be very small and not significant compared with the burdens imported with the inputs to the system. ''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.

Time Boundary	Data refer to the year 1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data supplied by 3 producers of PVC pipe in the Netherlands. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The effect of stabilisers have been ignored so that in the calculations all of the weight of the pipe is assumed to be PVC homopolymer. The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Data were supplied from 3 PVC pipe producers in the Netherlands. Their total production was 60 000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, mixed
Represents	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been

	translated into the nomenclature by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New name: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.
Method	European average data. Results are based on data supplied by 3 PVC pipe production plants i the Netherlands. Their total production was 60 000 tonnes.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports/htm/alphabetical.htm
Notes	The emissions to air from the VCM-factory are caused by shut-downs of the combustion oven. The continuous emission from the PVC-factory origines from drying of PVC and different point suction fans in the process. The discontinuous emission from the PVC-factory origines from disruption of the combustion oven when recycling VCM. The method is mentioned on Specific QMetaData for a few emitted substances. The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	218780.1073			mg	Air	Europe
	Input	Natural resource	Barytes	82.27558751			mg	Ground	Europe
	Input	Natural resource	Bauxite	451.7225229			mg	Ground	Europe
	Input	Natural resource	Bentonite	33.61737096			mg	Ground	Europe
	Input	Natural resource	Biomass	6490.178749			mg	Ground	Europe
	Input	Natural resource	Calcium fluoride	2.068606719			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	3.242083874			mg	Ground	Europe
	Input	Natural resource	Chalk	3.28E-14			mg	Ground	Europe
	Input	Natural resource	Chromium in ore	2.744552707			mg	Ground	Europe
	Input	Natural resource	Clay	8.755354461			mg	Ground	Europe
	Input	Natural resource	Crude oil	435716.6592			mg	Ground	Europe
	Input	Natural resource	Dolomite	19.72688836			mg	Ground	Europe
	Input	Natural resource	Feldspar	2.76E-20			mg	Ground	Europe
	Input	Natural resource	Ferromanganese in ore	1.465402317			mg	Ground	Europe
	Input	Natural resource	Granite	3.93E-02			mg	Ground	Europe
	Input	Natural resource	Gravel	5.947856854			mg	Ground	Europe
	Input	Natural resource	Hard coal	209158.7963			mg	Ground	Europe
	Input	Natural resource	Hydro energy	9.47E-01			MJ	Ground	Europe
	Input	Natural resource	Iron in ore	1656.046039			mg	Ground	Europe
	Input	Natural resource	Lead in ore	2.611861593			mg	Ground	Europe
	Input	Natural resource	Lignite	58477.58675			mg	Ground	Europe
	Input	Natural resource	Limestone	10767.14052			mg	Ground	Europe
	Input	Natural resource	Magnesium	1.05E-02			mg	Ground	Europe
	Input	Natural resource	Natural gas	564105.9232			mg	Ground	Europe
	Input	Natural resource	Nickel in ore	1.29E-02			mg	Ground	Europe
	Input	Natural resource	Nitrogen	17075.64469			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	6.550457352			MJ	Ground	Europe
	Input	Natural resource	Olivine	15.1239266			mg	Ground	Europe
	Input	Natural resource	Oxygen	5595.081445			mg	Ground	Europe
	Input	Natural resource	Peat	194.1007906			mg	Ground	Europe
	Input	Natural resource	Phosphate	1.099826135			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	5882.867032			mg	Ground	Europe
	Input	Natural resource	Rutile	4.71E-14			mg	Ground	Europe
	Input	Natural resource	Sand	471.1764262			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	649171.7045			mg	Ground	Europe
	Input	Natural resource	Sulphur in ore	15497.89069			mg	Ground	Europe
	Input	Natural resource	Talc	0			mg	Ground	Europe
	Input	Natural resource	Water, cooling	76535315			mg	Water	Europe
	Input	Natural resource	Water, process	11097396			mg	Water	Europe
	Input	Natural resource	Wood	94192.83475			mg	Ground	Europe
	Input	Natural resource	Zinc in ore	9.82E-02			mg	Ground	Europe
	Output	By-product	Recovered energy	1.035453087			MJ	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	2.405576995			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	343.8078237			mg	Air	Europe
	Output	Emission	Acid as H+	48.64134234			mg	Water	Europe
	Output	Emission	Al3+	0.280735848			mg	Water	Europe
	Output	Emission	Aldehydes	9.69E-03			mg	Air	Europe
	Output	Emission	As	8.86E-05			mg	Water	Europe
	Output	Emission	BOD	88.76038105			mg	Water	Europe

		Output	Emission	Ca2+	47.25678464			mg	Water	Europe
		Output	Emission	CFCs	0.956638979			mg	Air	Europe
		Output	Emission	Chloroorganics	0.263005065			mg	Water	Europe
		Output	Emission	Chloroorganics	36.94354354			mg	Air	Europe
		Output	Emission	Cl-	39396.06055			mg	Water	Europe
		Output	Emission	Cl2	1.683323789			mg	Air	Europe
		Output	Emission	Cl2	1.753902188			mg	Water	Europe
		Output	Emission	CN-	2.20E-02			mg	Water	Europe
		Output	Emission	CO	2584.379019			mg	Air	Europe
		Output	Emission	CO2	2351611.987			mg	Air	Europe
		Output	Emission	CO32-	63.06927647			mg	Water	Europe
		Output	Emission	COD	781.6731396			mg	Water	Europe
		Output	Emission	CrO3	4.64E-05			mg	Water	Europe
		Output	Emission	CS2	8.86E-05			mg	Air	Europe
		Output	Emission	Cu	1.009256013			mg	Water	Europe
		Output	Emission	Dissolved organics	1566.225769			mg	Water	Europe
		Output	Emission	Dissolved solids	2643.988633			mg	Water	Europe
		Output	Emission	Dust	4027.32577			mg	Air	Europe
		Output	Emission	F-	8.91E-03			mg	Water	Europe
		Output	Emission	F2	1.90E-04			mg	Air	Europe
		Output	Emission	Fe	4.572717336			mg	Water	Europe
		Output	Emission	H2	293.6113478			mg	Air	Europe
		Output	Emission	H2S	2.108456682			mg	Air	Europe
		Output	Emission	H2SO4	3.09E-05			mg	Air	Europe
		Output	Emission	HCl	189.4823868			mg	Air	Europe
		Output	Emission	HCN	1.61E-19			mg	Air	Europe
		Output	Emission	HF	5.9351272			mg	Air	Europe
		Output	Emission	Hg	0.392372566			mg	Air	Europe
		Output	Emission	Hg	2.16E-02			mg	Water	Europe
		Output	Emission	K+	180.4943267			mg	Water	Europe
		Output	Emission	Metals	4.497444295			mg	Air	Europe
		Output	Emission	Metals	65.07644989			mg	Water	Europe
		Output	Emission	Methane	10049.06236			mg	Air	Europe
		Output	Emission	Mg2+	2.153565189			mg	Water	Europe
		Output	Emission	N total	1.906979652			mg	Water	Europe
		Output	Emission	N2O	0.149475056			mg	Air	Europe
		Output	Emission	Na+	7849.743851			mg	Water	Europe
		Output	Emission	NH3	0.304864357			mg	Air	Europe
		Output	Emission	NH4+	4.349342854			mg	Water	Europe
		Output	Emission	Ni	0.860533652			mg	Water	Europe
		Output	Emission	NO3-	1.112653131			mg	Water	Europe
		Output	Emission	NOx	12812.93498			mg	Air	Europe
		Output	Emission	Oil	49.5959959			mg	Water	Europe
		Output	Emission	P2O5	16.81335165			mg	Water	Europe
		Output	Emission	PAH	80.4081889			mg	Air	Europe
		Output	Emission	Pb	3.48E-03			mg	Water	Europe
		Output	Emission	Pb	5.30E-04			mg	Air	Europe
		Output	Emission	Phenol	3.965663818			mg	Water	Europe
		Output	Emission	S2-	0.964297231			mg	Water	Europe
		Output	Emission	SO2	11842.15918			mg	Air	Europe
		Output	Emission	SO42-	4111.916576			mg	Water	Europe
		Output	Emission	Suspended solids	1891.486185			mg	Water	Europe
		Output	Emission	Thiols	4.49E-02			mg	Air	Europe
		Output	Emission	Vinyl chloride	1.268456259			mg	Water	Europe
		Output	Emission	Vinyl chloride	237.5967771			mg	Air	Europe
		Output	Emission	VOC	2178.474437			mg	Air	Europe
		Output	Emission	VOC	27.51965399			mg	Water	Europe
		Output	Emission	VOC	3.243629677			mg	Water	Europe
		Output	Emission	Zn2+	4.12E-03			mg	Water	Europe
		Output	Product	PVC pipe	1			kg	Technosphere	Europe
		Output	Residue	Construction	1.62E+01			mg	Ground	Europe
		Output	Residue	Industrial	4391.559807			mg	Ground	Europe
		Output	Residue	Inert chemicals	11542.68264			mg	Ground	Europe
		Output	Residue	Metals	1224.865415			mg	Ground	Europe
		Output	Residue	Mineral	57266.56397			mg	Ground	Europe

	Output	Residue	Paper	9.30E+02			mg	Ground	Europe
	Output	Residue	Plastics	1157.321069			mg	Ground	Europe
	Output	Residue	Regulated chemicals	5028.435931			mg	Ground	Europe
	Output	Residue	Slags & ashes	13887.05387			mg	Ground	Europe
	Output	Residue	To incinerator	31.18908632			mg	Technosphere	Europe
	Output	Residue	To recycling	14.4017352			mg	Technosphere	Europe
	Output	Residue	Unspecified	71.42458609			mg	Ground	Europe
	Output	Residue	Wood waste	8.89E+02			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PVC pipe. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME´s web site http://lca.apme.org. -- Documented by Sofia Boström, Volvo Technological Development Corporation Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 24 May 2002 --
Intended User	1. LCA practitioners in genera
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from production of the polymer resin to the finished PVC pipe.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of PVC pipe, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: -Plastic waste management stidues - Internal company benchmarking - Product development. Detailed environmental information to customers of APME memebers for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-1993, the period to which the oldest group of Eco-profiles data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - .
Practitioner	Ian Boustedt - .
Reviewer	
Applicability	European average data. Data were supplied from 3 PVC pipe producers in the Netherlands. Their total production was 60 000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for PVC pipe production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of PVC pipe in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages.

	Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO_2 emission. CO_2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO_2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite ($Ba(SO_4)$ Barytes Bauxite ($Al_2O_3*H_2O$) Bauxite Chromium (Cr^{3+}, Cr^{6+}) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P_2O_5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH_4^+ Carbon disulfide CS_2 Carbonate CO_3^{2-} Chlorine Cl_2 Chromium oxide CrO_3 Copper (Cu^+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F_2) F_2 Hydrocyanic HCN Hydrogen H_2 Iron, Fe^{2+}, Fe^{3+} Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni^{++}) Ni Nitrate (NO_3) NO_3^- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H_2S_4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn^{++}) Zn Ni (Ni^{++}, Ni^{3+}) Ni

SPINE LCI dataset: Production of PVC unplasticised film APME

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of PVC unplasticised film APME
Functional Unit	1 kg Unplasticised PVC film
Functional Unit Explanation	In the process for producing film the polymer resin is extruded as a continuous tube to form a thin film. In this case the polymer used as raw material is PVC.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is aqcuired. The main groups of operations covered in the study are the production of the polymer resin, the transport of the resin to the converter, the conversion process itself and the packaging of the finished component for onward dispatch. Also, the production of fuels and energy used in the processes and transports are included. Polymer resins are delivered to converters either in bulk tankers or in plastic sacks. In this case it is assumed that all resin is delivered by bulk tanker, 20 tonne. The delivery distance is assumed to be 100 km one way. The bulk tanker must make an empty return and the fuel consumtion of an ampty tanker is assumed to be 70% of that of a fully laden vehicle. The data have been obtained for the production of 10 000 tonne of unplasticised PVC (UPVC) film which is produced by four factories in Germany. The UPVC film is produced in a manner similar to that for low density PE film. The following description of the process is obtained from the Ecoprofiles report for LDPE film production. The conversion process: Molten polymer is extruded as a continuous tube. As it leaves the extrusion die, the tube is inflated with air to form a bubble and when the bubble reaches the appropriate size it tis cooled by air which changes it into a solid film. The region where the solodification occurs, known as the ''frost line'', is the region where the required film gauge (or thickness) is reached. The tube is then guided by collapsing boards to be gradually flattened as it approaches the pinch rolls. When the lay-flat film passes between them, the top of the bubble is effectively sealed. The seal is entirely dependent upon the nip pressures since the two plastic surfaces do not stick together. The lay-flat tubing is fed to the winding equipment via a pre-treatment and slitting unit. Slitting and trimming is a continuous cutting operation. Finally, the finished film is packaged for despatch. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries	
Nature Boundary	The study take no account of any air emissions arising directly from the conversion process. While it is impossible to carry out such a process without generating some emissions, the quantities involved are thought to be very small and not significant compared with the burdens imported with the inputs to the system.

	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1995. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data supplied by 4 producers of unplasticised PVC film in Germany. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Data were supplied from 4 unplasticised film producers Germany. Their total production was 10 000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Derived, mixed
Represents	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New name: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.
Method	European average data. Results are based on data supplied by 4 PVC unplasticised film production plants in Germany. Their total production was 10 000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied whereever there have been sufficient data from upstream raw material and fuel producers. In verticall averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the caluclations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emissions. For fuels and feedstock materials, actual gross calorific values (energy conten) have been used in teh calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened ind imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports /htm/alphabetical.htm
Notes	The emissions to air from the VCM-factory are caused by shut-downs of the combustion oven. The continuous emission from the PVC-factory origines from drying of PVC and different point suction fans in the process. The discontinuous emission from the PVC-factory origines from disruption of the combustion oven when recycling VCM. The method is mentioned on Specific QMetaData for a few emitted substances. The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	226465.0011			mg	Air	Europe
	Input	Natural resource	Barytes	84.97079864			mg	Ground	Europe
	Input	Natural resource	Bauxite	464.8897132			mg	Ground	Europe
	Input	Natural resource	Bentonite	34.04967774			mg	Ground	Europe
	Input	Natural resource	Biomass	6847.891395			mg	Ground	Europe
	Input	Natural resource	Calcium fluoride	2.071487001			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	3.348387531			mg	Ground	Europe
	Input	Natural resource	Chalk	3.39E-14			mg	Ground	Europe
	Input	Natural resource	Chromium in ore	0.778850448			mg	Ground	Europe
	Input	Natural resource	Clay	9.18214958			mg	Ground	Europe
	Input	Natural resource	Crude oil	438858.1283			mg	Ground	Europe
	Input	Natural resource	Dolomite	9.343872643			mg	Ground	Europe
	Input	Natural resource	Feldspar	2.85E-20			mg	Ground	Europe
	Input	Natural resource	Ferromanganese in ore	0.696928012			mg	Ground	Europe
	Input	Natural resource	Granite	4.06E-02			mg	Ground	Europe
	Input	Natural resource	Gravel	2.812554357			mg	Ground	Europe
	Input	Natural resource	Hard coal	238301.9915			mg	Ground	Europe
	Input	Natural resource	Hydro energy	9.97E-01			MJ	Ground	Europe
	Input	Natural resource	Iron in ore	809.0008864			mg	Ground	Europe
	Input	Natural resource	Lead in ore	2.666250357			mg	Ground	Europe
	Input	Natural resource	Lignite	52667.00909			mg	Ground	Europe
	Input	Natural resource	Limestone	11133.77833			mg	Ground	Europe
	Input	Natural resource	Magnesium	0			mg	Ground	Europe
	Input	Natural resource	Natural gas	552677.5183			mg	Ground	Europe
	Input	Natural resource	Nickel in ore	1.33E-02			mg	Ground	Europe

	Input	Natural resource	Nitrogen	17656.69775			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	7.83769777			MJ	Ground	Europe
	Input	Natural resource	Olivine	7.151629015			mg	Ground	Europe
	Input	Natural resource	Oxygen	5762.781496			mg	Ground	Europe
	Input	Natural resource	Peat	194.7289455			mg	Ground	Europe
	Input	Natural resource	Phosphate	1.129365304			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	6075.758487			mg	Ground	Europe
	Input	Natural resource	Rutile	4.86E-14			mg	Ground	Europe
	Input	Natural resource	Sand	487.1139055			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	670510.2135			mg	Ground	Europe
	Input	Natural resource	Sulphur in ore	16003.43093			mg	Ground	Europe
	Input	Natural resource	Talc	0			mg	Ground	Europe
	Input	Natural resource	Water, cooling	64240117			mg	Water	Europe
	Input	Natural resource	Water, process	11572858			mg	Water	Europe
	Input	Natural resource	Wood	29697.18345			mg	Ground	Europe
	Input	Natural resource	Zinc in ore	0.100251013			mg	Ground	Europe
	Output	By-product	Recovered energy	1.069395354			MJ	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	2.484452694			mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	355.080829			mg	Air	Europe
	Output	Emission	Acid as H+	49.95426778			mg	Water	Europe
	Output	Emission	Al3+	0.289940807			mg	Water	Europe
	Output	Emission	Aldehydes	1.00E-02			mg	Air	Europe
	Output	Emission	As	9.15E-05			mg	Water	Europe
	Output	Emission	BOD	91.12961184			mg	Water	Europe
	Output	Emission	Ca2+	48.80627232			mg	Water	Europe
	Output	Emission	CFCs	0.98800591			mg	Air	Europe
	Output	Emission	Chloroorganics	0.271628528			mg	Water	Europe
	Output	Emission	Chloroorganics	38.15482967			mg	Air	Europe
	Output	Emission	Cl-	40688.80771			mg	Water	Europe
	Output	Emission	Cl2	1.738508371			mg	Air	Europe
	Output	Emission	Cl2	1.811410329			mg	Water	Europe
	Output	Emission	CN-	2.26E-02			mg	Water	Europe
	Output	Emission	CO	2621.483825			mg	Air	Europe
	Output	Emission	CO2	2390012.43			mg	Air	Europe
	Output	Emission	CO32-	65.13723491			mg	Water	Europe
	Output	Emission	COD	804.9339146			mg	Water	Europe
	Output	Emission	CrO3	4.79E-05			mg	Water	Europe
	Output	Emission	CS2	9.15E-05			mg	Air	Europe
	Output	Emission	Cu	1.042348188			mg	Water	Europe
	Output	Emission	Dissolved organics	1614.893657			mg	Water	Europe
	Output	Emission	Dissolved solids	2733.761873			mg	Water	Europe
	Output	Emission	Dust	4226.948212			mg	Air	Europe
	Output	Emission	F-	6.04E-03			mg	Water	Europe
	Output	Emission	F2	1.44E-04			mg	Air	Europe
	Output	Emission	Fe	4.705593714			mg	Water	Europe
	Output	Emission	H2	303.2384769			mg	Air	Europe
	Output	Emission	H2S	2.089583024			mg	Air	Europe
	Output	Emission	H2SO4	3.19E-05			mg	Air	Europe
	Output	Emission	HCl	207.0084483			mg	Air	Europe
	Output	Emission	HCN	1.66E-19			mg	Air	Europe
	Output	Emission	HF	7.068912337			mg	Air	Europe
	Output	Emission	Hg	0.405237946			mg	Air	Europe
	Output	Emission	Hg	2.23E-02			mg	Water	Europe
	Output	Emission	K+	186.4124977			mg	Water	Europe
	Output	Emission	Metals	3.926617556			mg	Air	Europe
	Output	Emission	Metals	68.75488203			mg	Water	Europe
	Output	Emission	Methane	8581.620343			mg	Air	Europe
	Output	Emission	Mg2+	2.224177753			mg	Water	Europe
	Output	Emission	N total	1.866385614			mg	Water	Europe
	Output	Emission	N2O	0.154376146			mg	Air	Europe
	Output	Emission	Na+	8107.013817			mg	Water	Europe
	Output	Emission	NH3	0.314860424			mg	Air	Europe
	Output	Emission	NH4+	3.907177503			mg	Water	Europe
	Output	Emission	Ni	0.888749416			mg	Water	Europe
	Output	Emission	NO3-	1.180142442			mg	Water	Europe

	Output	Emission	NOx	11742.76583			mg	Air	Europe
	Output	Emission	Oil	52.4828541			mg	Water	Europe
	Output	Emission	P2O5	17.3771737			mg	Water	Europe
	Output	Emission	PAH	80.99971313			mg	Air	Europe
	Output	Emission	Pb	2.54E-04			mg	Air	Europe
	Output	Emission	Pb	3.05E-03			mg	Water	Europe
	Output	Emission	Phenol	3.397118735			mg	Water	Europe
	Output	Emission	S2-	0.988930305			mg	Water	Europe
	Output	Emission	SO2	11699.15197			mg	Air	Europe
	Output	Emission	SO42-	4246.763473			mg	Water	Europe
	Output	Emission	Suspended solids	1885.516554			mg	Water	Europe
	Output	Emission	Thiols	3.00E-02			mg	Air	Europe
	Output	Emission	Vinyl chloride	1.310047268			mg	Water	Europe
	Output	Emission	Vinyl chloride	245.3872622			mg	Air	Europe
	Output	Emission	VOC	2296.668588			mg	Air	Europe
	Output	Emission	VOC	28.31443123			mg	Water	Europe
	Output	Emission	VOC	3.301485874			mg	Water	Europe
	Output	Emission	Zn2+	4.25E-03			mg	Water	Europe
	Output	Product	PVC unplasticised film	1			kg	Technosphere	Europe
	Output	Residue	Construction	1.68E+01			mg	Ground	Europe
	Output	Residue	Industrial	4482.583183			mg	Ground	Europe
	Output	Residue	Inert chemicals	11918.05702			mg	Ground	Europe
	Output	Residue	Metals	363.9608954			mg	Ground	Europe
	Output	Residue	Mineral	61424.21477			mg	Ground	Europe
	Output	Residue	Paper	1.84E+02			mg	Ground	Europe
	Output	Residue	Plastics	869.5277076			mg	Ground	Europe
	Output	Residue	Regulated chemicals	5194.006317			mg	Ground	Europe
	Output	Residue	Slags & ashes	15043.38398			mg	Ground	Europe
	Output	Residue	To incinerator	32.21173534			mg	Technosphere	Europe
	Output	Residue	To recycling	14.87394911			mg	Technosphere	Europe
	Output	Residue	Unspecified	7142.540773			mg	Ground	Europe
	Output	Residue	Wood waste	2.87E+02			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for PVC unplasticised film. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME´s web site http://lca.apme.org. -- Documented by Sofia Boström, Volvo Technological Development Corporation Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 24 May 2002 --
Intended User	1. LCA practitioners in genera
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from production of the polymer resin to the finished UPVC film.
Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of UPVC film, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: -Plastic waste management stidues - Internal company benchmarking - Product development. Detailed environmental information to customers of APME memebers for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-1993, the period to which the oldest group of Eco-profiles data referred. Also the quality of data reported by the companies has improved since then.

Commissioner	APME - .
Practitioner	Ian Boustedt - .
Reviewer	
Applicability	European average data. Data were supplied from 4 PVC unplasticised film producers in Germany. Their total production was 10 000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for PVC unplasticised film production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of PVC unplasticised film in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood

	EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

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SPINE LCI dataset: Production of quartz sand

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Production of quartz sand
Functional Unit	0,675 kg sand
Functional Unit Explanation	0,675 kg sand is used for the sand form in the casting process for producing one bearing housing, SNL 511-609, at SKF Mekan AB in Katrineholm. Since the sand is needed (and bought from the same sand pit) also for the sand form in the casting process for guide rings, the same dataset is used. The dataset is used unchanged for our specific case, and thus the functional unit is 0,675 kg sand. The figure 0,675 has nothing to do with guide rings as such.
Process Type	Gate to gate
Site	Broby
Sector	Other mining
Owner	Broby
Technical system description	This activity describes a process step included in the whole system activity ''Production of guide rings used for spherical roller bearings''', also available in the SPINE@CPM database. The guide ring is manufactured at SKF Mekan AB in Katrineholm and the process consists of several steps. See the activity ''Production of guide rings used for spherical roller bearings'' for details. The guide ring will finally be mounted into the SKF Spherical Roller Bearing 232/530. The function of the guide ring is to assure that the rollers stay in the raceways of the bearing.

	Production of quartz sand: The quartz sand used for the sand form in the casting process at SKF Mekan AB in Katrineholm come from a sand pit in Broby, Sweden. Digging machines are used in the sand pit, and these are consuming diesel. The sand is dried to lower the moisture content and in the drying process, fuel oil is used. The production of electricity, diesel and heavy fuel oil are NOT included in this dataset and must be taken into account to obtain a total environmental impact. The combustion of diesel and heavy fuel oil are NOT included in this dataset and must be taken into account to obtain a total environmental impact.

System Boundaries

Nature Boundary	No emissions to air and water are known.
Time Boundary	The data was collected during the autumn 2002 and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The process takes place in Broby, Sweden
Other Boundaries	The production of electricity, diesel and heavy fuel oil are NOT included in this dataset and must be taken into account to obtain a total environmental impact. The combustion of diesel and heavy fuel oil are NOT included in this dataset and must be taken into account to obtain a total environmental impact.
Allocations	Allocations were made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature by CPM (CPM 2000:2). The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New name: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.
Method	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	The emissions to air from the VCM-factory are caused by shut-downs of the combustion oven. The continuous emission from the PVC-factory origines from drying of PVC and different point suction fans in the process. The discontinuous emission from the PVC-factory origines from disruption of the combustion oven when recycling VCM. The method is mentioned on Specific QMetaData for a few emitted substances. The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Diesel	0.1			MJ	Technosphere	
	Input	Refined resource	Electricity	7200			J	Technosphere	
	Input	Refined resource	Heavy fuel oil	0.24			MJ	Technosphere	
	Output	Product	Sand	0.675			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.

Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data set is applicable for sand digging and drying at the specific site in Broby, Sweden.
About Data	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	

SPINE LCI dataset: Production of rolled aluminium sheet

Administrative	
Finished	Y
Date Completed	2002-05-07
Copyright	EAA
Availability	Public

Technical System	
Name	Production of rolled aluminium sheet
Functional Unit	1000 kg rolled aluminium sheet
Functional Unit Explanation	Typical delivered condition of rolled aluminium sheet: - surface mill-finish - without lubrication/foil cadding/intermediate paper - wooden EURO-pallets, sheets wrapped in PE foil, steel bands
Process Type	Gate to gate
Site	Not specified. See Geographical boundaries for further information.
Sector	Materials and components
Owner	Not specified. See Geographical boundaries for further information.
Technical system description	The inventory data cover rolled aluminium sheet production, e.g. sheet used in Europe for the outer parts of cars in the following typical delivered condition: - surface mill-finish - without lubrication/foil cadding/intermediate paper - wooden EURO-pallets, sheets wrapped in PE foil, steel bands The internal recycling of process scrap during sheet production is included. --- The starting material for the production of rolled aluminium sheet is aluminium slab (rolling ingot) with alloy properties tailored to final use weighting up to 25 tinnes, and of a thickness of 500-700 mm. In this documentation form the starting material is referred to as ''aluminium ingot'' when it comes from an external primary aluminium or secondary aluminium plant. The starting material aluminium slab is also produced by remelting process scrap (Ingot remelting and casting) and this input is referred to as ''casting scrap''. The aluminium ingot and casting scrap goes to the first process step ''Sawing and scalping''. After heating the aluminium slab to around 500 degrees Celsius, it is hot rolled, typically to

	2-5 mm thickness, followed by cold rolling to the final gauge. An alternative production route, starting with continuous cast strip, is not considered here. The process steps are: - Production of semi-finished aluminium - 1. Sawing and scalping 2. Hot rolling 3. Cold rolling 4. Solution heat treatment 5. Finishing 6. Packaging - Recycling of process scrap - 7. Ingot remelting and casting Production of electricity is included in the system. Some further details on the recycling of process scrap is given below. From the process steps Sawing and scalping (154 kg), Hot rolling (139 kg), Cold rolling (73 kg), and Finishing (110 kg) scrap is going to the process step Ingot remelting and casting. The values in brackets is the amount of scrap delivered from each process step. 21 kg scrap is recycled within the process ingot remelting and casting.

System Boundaries

Nature Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- Cut-off criteria through out this inventory is basically relevance, as checked by the industry expert team monitoring the work and confirmed by reviewer I. Boustead. As a rough guideline ''less than 1% of total mass'' is applied for the inputs, i.e if the input is less than 1% of the total mass, then it is not included in the inventory table. The base for the choices of included inventory parameters is not further described in the EAA report.
Time Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- The data derived from an industry survey from 1998 and includes literature data from reports dated 1998 and 1999.
Geographical Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- It is not always explicit in the report where the different included process steps take place. Data may be acquired from outside of Europe, e.g. regarding ancillary materials. See litterature references (LitteratureRef) next to the flow table (FlowMetaData) for further information about the data sources for each process step.
Other Boundaries	See Nature boundaries for a specification of the cut-off criteria that has been applied.
Allocations	Allocations are not explicitly specified in the Environmental Profile Report 2000.
Systems Expansions	System expansions are not explicitly specified in the Environmental Profile Report 2000.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Not relevant.
Method	PRODUCTION OF SEMI-FINISHED ALUMINIUM The data derive from an industry survey with a coverage ranging from 20% to 70%, depending on the product in question. INGOT REMELTING AND CASTING (RECYCLING OF PROCESS SCRAP) Data were obtained from aluminium-integrated cast house operations, i.e. cast houses associated with semi-finished aluminium production. The 1998 survey on semi-finished aluminium products also encompassed aluminium-integrated cast houses, with 37% coverage for the recycling of process scrap. TRANSPORTS Transport energy and air emission data have been taken from SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 ELECTRICITY For all manufacturing operations, the consumption of fossil fuels and emissions linked to electricity production was calculated according to the UCTPE 94 electrical energy model as described in BUWAL 250. Emissions from combustion only, i.e. without the precombustion contribution, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of precombustion and combustion in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, inview of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors.

Literature Reference	---Rolled sheet production and process scrap recycling Industry survey from 1998 ---Transport energy, electricity, and air emission - SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems.
Notes	In this inventory profile it is possible to identify which process step (Rolled sheet production, Process scrap recycling) the flow is connected to and if it derives from the energy use, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: This substance is connected both to the rolled sheet production and the process scrap recycling.	Input	Natural resource	Brown coal	75.7			kg	Ground	
Notes: This substance is connected both to the rolled sheet production and the process scrap recycling.	Input	Natural resource	Crude oil	21.0			kg	Ground	
Notes: This substance is connected both to the rolled sheet production and the process scrap recycling.	Input	Natural resource	Hard coal	71.9			kg	Ground	
Notes: This substance is connected both to the rolled sheet production and the process scrap recycling.	Input	Natural resource	Natural gas	99.3			kg	Ground	
Notes: 6,12 kg is alloying additives as master alloys and 6,83 kg in pure form. This substance is connected to the process scrap recycling.	Input	Refined resource	Alloying additives	12.95			kg	Technosphere	
	Input	Refined resource	Aluminium ingot	1012			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Ar-gas	0.91			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Chlorine	0.008			kg	Technosphere	
Notes: Includes electricity produced by nuclear and hydro power plants (nuclear 251 kWh and hydro 102 kWh). This substance is connected both to the rolled sheet production and the process scrap recycling.	Input	Refined resource	Electricity	353			kWh	Technosphere	
Notes: Fluxing agents are salts. This substance is connected to the process scrap recycling.	Input	Refined resource	Fluxing agents	0.38			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Nitrogen	0.40			kg	Technosphere	
Notes: The paper and cardboard is used for packaging. This substance is connected to the rolled sheet production.	Input	Refined resource	Paper and cardboard	0.10			kg	Technosphere	
Notes: The plastics is used for packaging. This substance is connected to the rolled sheet production.	Input	Refined resource	Plastics	0.40			kg	Technosphere	
Notes: This substance is connected to the process scrap recycling.	Input	Refined resource	Refractory materials	0.50			kg	Technosphere	
Notes: This substance is connected to the rolled sheet production.	Input	Refined resource	Rolling oil	3.8			kg	Technosphere	
Notes: Steel is used for packaging. This substance is connected to the rolled sheet production.	Input	Refined resource	Steel	0.50			kg	Technosphere	
Notes: Water is used for cooling. This substance is connected both to the rolled sheet production and the process scrap recycling.	Input	Refined resource	Water	42			m3	Technosphere	
Notes: Wood is used for packaging. This substance is connected to the rolled sheet production.	Input	Refined resource	Wood	0.10			kg	Technosphere	
Notes: Aluminium skimmings for recycling.	Output	By-product	Aluminium skimmings	16.0			kg	Technosphere	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	CH4	1.3			kg	Air	
Notes: This emission derives from the process scrap recycling.	Output	Emission	Chlorides	0.0016			kg	Air	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	Chlorides	1.3			kg	Water	

Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	CO	0.15			kg	Air	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	CO2	499			kg	Air	
Notes: This emission derives from the rolled sheet production.	Output	Emission	COD	0.079			kg	Water	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	Dust	0.33			kg	Air	
Notes: HC, other than CH4. This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	HC	0.40			kg	Air	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is partly connected to the energy use.	Output	Emission	HCl	0.059			kg	Air	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	HF	0.0048			kg	Air	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	NH3	0.00077			kg	Air	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	NOx	0.81			kg	Air	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	Oil/grease	0.033			kg	Water	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	SO2	1.56			kg	Air	
Notes: This emission derives both from the rolled sheet production and the process scrap recycling. It is connected to the energy use.	Output	Emission	Suspended particles	0.20			kg	Water	
Notes: This emission derives from the rolled sheet production.	Output	Emission	VOC	0.44			kg	Air	
	Output	Product	Rolled aluminium sheet	1000			kg	Technosphere	
Notes: This residue derives from the rolled sheet production.	Output	Residue	Hazardous waste	4.8			kg	Technosphere	
Notes: The oil is reprocessed or burnt. This residue derives from the rolled sheet production.	Output	Residue	Oil	2.3			kg	Technosphere	
Notes: This residue derives both from the rolled sheet production and the process scrap recycling.	Output	Residue	Solid waste unspecified	7.1			kg	Technosphere	

About Inventory

Publication	Environmental Profile Report for the European Aluminium Industry, European Aluminium Association, April 2000 -- Data documented by: Maria Erixon, IMI, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 8 May 2002 --
Intended User	LCA-practitioners.
General Purpose	The European Aluminium Association (EAA) aims to contribute to further environmental improvements in aluminium products in a life cycle concept.

Detailed Purpose	To provide LCA-practitioners with detailed and up-to-date information representing the aluminium The purpose with the Environmental Profile Report 2000 is to provide LCA-practitioners with detailed and up-to-date information representing the aluminium industry activities in Europe. The purposes with formatting the Environmental Profile Report 2000 for the European Aluminium Industry to the data documentation format SPINE, according to the data documentation criteria applied at Centre for environmental assessment of Product and Material systems (CPM) are: - CPM and European Aluminium Association (EAA) are anxious to provide life cycle assessment (LCA) practitioners with accurate and up to date environmental data for aluminium production. - EAA is interested in the SPINE formatting procedure and result, as the format is a base for (and therefor somewhat similar to) the new Technical Specification in ISO, ISO 14048, regarding LCA data documentation format. - EAA is interested in the CPM data quality control and documentation criteria.
Commissioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Practitioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Reviewer	Dr. Ian Boustead, - 2 Black Cottages West Grinstead, Horsham GB-West Sussex RH13 7BD
Applicability	--- SPECIFIC INFORMATION FOR THIS DATA SET --- ENERGY USE IN THE DIFFERENT INCLUDED PROCESS STEPS The energy directly consumed by the operations enclosed within the system bounderies, i.e. in the various production steps, are presented below. See the headline ''DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION'' in About Data for further information. ---Production of semi-finished aluminium--- Fuel oil (kg) 0,34 Gas (kg) 46,5 Electricity UCTPE* (kWh) 547 ---Process scrap recycling--- Fuel oil (kg) 0,41 Gas (kg) 33 Electricity UCTPE* (kWh) 75 * UCTPE 94 is an electrical energy model for energy supporting all processes in this system (including transports), except electrolysis and cast house. It is described in BUWAL 250, see litterature references. ENERGY CONSUMPTION - INFLUENCE OF ALLOY GRADE AND INGOT HOMOGENEISATION TREATMENT This data set represents an average aluminium alloy. Different alloy types have different energy consumption data; some alloys undergo ingot homogeneisation thermal treatment; hard alloys need more energy for rolling than soft alloys or unalloyed aluminium. In the table below you can find some examples of the variation. The values are presented per 1000 kg rolled aluminium sheet. Alloy groups: I. includes unalloyed aluminium (all 1xxx designations) II. includes alloyed aluminium designated 3xxx, 5xxx (Mg<2,5%), 6xxx and 8xxx III. includes alloyed aluminium designated 2xxx, 5xxx (Mg>2,5%) and 7xxx Electricity consumption (kWh) I II III Overall weighted average non-homogenised 592 642 661 622 homogenised 637 687 706 667 Gas consumption (kg) non-homogenised 79,3 79,6 79,5 79,5 homogenised 94,3 94,6 94,5 94,5 --- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- RECOMMENDATIONS BY EAA WHEN USING THE DATA The data provided by the EAA members for their own process steps are the most up-to-date average data available for these processes, and it is recommended that they be used for LCA purposes. Older literature data should be disregarded, as it may no longer be representative due to technological improvements, progress in operating performance, changes with regard to raw materials or waste treatment, etc.

	To complete the product system inventory, data - on the production of consumer products, from semi-fabricated aluminium, - on the performance of consumer products in the use phase, and - on the recovery of scrap prior to remelting at the end of the product's useful life should be acquired. EAA recommend that these data be used in LCA studies in accordance with methodologies within the framework of the international standards in the ISO 14040-series. RELATED DATA SETS IN SPINE DATA FORMAT The data presented in the Environmental Profile Report is reformatted in to the SPINE format and structured according to the SPINE concept in as many separate activities (sub-systems) as possible. The system scope for the study as a whole is primary aluminium production, semi-finished aluminium production, and recycling. The SPINE formatting resulted in 7 activities. These activities are all published in the SPINE@CPM database. The production and recycling step are intended to be used together. For example, to obtain a cradle to gate-system for rolled aluminium sheet, the activity Primary aluminium production should be connected to the activity Production of rolled aluminium sheet. A recycling step (Aluminium recycling by refiners) could also be connected to such a system, depending on the scope. -- List of activities formatted in the SPINE-format, published in SPINE@CPM -- Primary aluminium production 1. Primary aluminium production Semi-finished aluminium product fabrication 2. Production of rolled aluminium sheet 3. Production of extruded aluminium profiles 4. Production of 0,02-0,2 mm single-rolled aluminium foil 5. Production of 0,005-0,02 mm double-rolled aluminium foil Recycling 6. Re-melting of aluminium scrap 7. Aluminium recycling by refiners Please note: The recycling process 6. Re-melting of aluminium scrap is included in the semi-finished aluminium product fabrication, i.e. activities 2-5. When designing a product system with the activities above where recycled aluminium is regarded, the activity Aluminium recycling by refiners should be used. The Re-melting of aluminium activity is only a specification if the user is specifically interested in this process step. RECYCLING RATES FOR ALUMINIUM PRODUCTS AFTER USE After use, aluminium products are a valuable re-usable resource. The European recycling rates for end products are currently around 95% for the automotive sector and 85% for the building sector. IMPROVEMENTS IN THE ENVIRONMENTAL PERFORMANCE OF ALUMINIUM PRODUCTS AND PROCESSES OVER THE PAST FEW YEARS Over the past few years EAA has achieved major improvements in the environmental performance of its production processes by means of the following: - improvement on existing technology - development and introduction of new technology and operations - increased recycling of all materials in the production process. Examples of major environmental improvements in aluminium products achieved over the past few years include: - weight reduction by downgauging in the packaging sector - energy savings through weight reduction and subsequent fuel reduction in the transport sector - reduction of maintenance in the building sector The previous Ecological Profile Report from EAA was published in 1996.
About Data	--- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- PRECISION According to EAA, the environmental data figures in the inventory table are usually accurate to a precision of 5%. DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION The electricity supply systems and fuel production and use (transport energy and emission data) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250' and EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems. All emissions connected with total fuel consumption (i.e. production and combustion of oil, gas or coal) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250', table 16.9. Emissions from combustion only, i.e. excluding the contribution of the production

	of the fuel, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of production and combustion of fuels in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, in view of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors. REVIEW OUTSPOKE Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, April 2000, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. Ian Bousteds' review comments on the Environmental Profile Report for the European Aluminium Industry, April 2000: ''...I have received the detailed calculations on which this present environmental report is based. All of the queries that I raised after working through these reports were answered satisfactory.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Good-quality data were supplied by the EAA member companies, and the number of companies participating provides good coverage of the various processes, meaning that the results can be regarded as representative of the industryas a whole for the production of primary aluminium and subsequent conversion processes.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Because of the very fragmented nature of the recycling industry and wide variations in practices, it is recognised that the data presented for this sector of the industry can only be regarded as indicative. Nevertheless it is helpful to have such information from an authorative source.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000
Notes	REVIEWER Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. See AboutData for review comments.

SPINE LCI dataset: Production of self-adhesive labels etc used in the manufacturing, food and pharmaceutical industry

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Production of self-adhesive labels etc used in the manufacturing, food and pharmaceutical industry
Functional Unit	1996
Functional Unit Explanation	The amounts given in the table shovs the total material flows of one year (1996). The extent of the production is not stated in the amount of manufactured labels.
Process Type	Gate to gate
Site	Strålfors Svenska AB Division Etikett Box 126 421 22 Västra Frölunda Sweden
Sector	Materials and components
Owner	Strålfors Svenska AB Division Etikett Box 126 421 22 Västra Frölunda Sweden

Technical system description	Production of self-adhesive labels and other information carriers used in the manufacturing, food and pharmaceutical industry. The methods used for printing are screen printing and letterpress printing. Besides this the company also produces repro and printing blocks.

System Boundaries	
Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1996
Data Type	Unspecified
Represents	Not relevant.
Method	Study the Environmental Report for 1996. The amounts in the table are taken directly from the environmental report, and shows the resourses, residues and emissions for the annual production of 1996.
Literature Reference	---Rolled sheet production and process scrap recycling Industry survey from 1998 ---Transport energy, electricity, and air emission - SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems.
Notes	In this inventory profile it is possible to identify which process step (Rolled sheet production, Process scrap recycling) the flow is connected to and if it derives from the energy use, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Screen coating, consist of PVA Polyvenylacetate and pigment on a polyesterfilm.	Input	Refined resource	Capilex-film	385			m2	Technosphere	
Notes: CUFD-dev A+B (developer that consist of hydrokenone potassium hydroxide dietanolamin), manufacturer Howgraphic AB	Input	Refined resource	Cronaline	80			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Cleaner	Input	Refined resource	Duwanol PM	475			kg	Technosphere	
Notes: Supplier is Göteborgs energi.	Input	Refined resource	Electricity	1864			MWh	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Cleaner	Input	Refined resource	ExBensin 94/99	200			kg	Technosphere	
Notes: Paint solvent (methyladipat, methylglutarat and methylsuccinat), manufactured by Hiab, held in a secluded system	Input	Refined resource	H-14 Stripper	400			kg	Technosphere	
	Input	Refined resource	Heat embossed foil	123000			m2	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Cleaner	Input	Refined resource	Methyl ethyl ketone	1000			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Supplier is VA-verket, Göteborg	Input	Refined resource	Municipal water	1534			m3	Technosphere	

Date concieved: 1996 Data type: Unspecified Notes: Supplier is Göteborgs energi	Input	Refined resource	Natural gas	795			MWh	Technosphere	
Notes: Based on solvents, manufacturer Edvard Schneidler AB	Input	Refined resource	OT svart	60			kg	Technosphere	
Notes: Reflex etc.	Input	Refined resource	Other input	58000			m2	Technosphere	
	Input	Refined resource	Other paper	3853000			m2	Technosphere	
Notes: UV-based, based on acrylate, manufacturer Casco (2444 kg) The rest is manufavured by Casco and Aarberg AG (1043 kg)	Input	Refined resource	paint/enamel	3487			kg	Technosphere	
	Input	Refined resource	Polyester	388000			m2	Technosphere	
	Input	Refined resource	Polythene	840000			m2	Technosphere	
Notes: Is used to wash out capilex-film from the screen, composed by NaOH, manufactured by Schweiziska Aniliinkompaniet AB.	Input	Refined resource	Pregan Pasta	270			kg	Technosphere	
Notes: Is used to wash out capilex-film from the screen, composed by organic solvents and emulsions, manufactured by Schweiziska Aniliinkompaniet AB.	Input	Refined resource	Prigan C 444M	255			kg	Technosphere	
Notes: Photo polymer plate for printing, consist of polyamide, manufactured by Tojobo/Anpec.	Input	Refined resource	Printight	340			m2	Technosphere	
	Input	Refined resource	PVC	50000			m2	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Used for glueing the screen, manufacturer Stork (2 komponents lim)	Input	Refined resource	SCR 53	6			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Screen paint consist of the following types: 26-set based on solvents (aromatic and alifatiska hydrocarbon), manufacturer Aarberg AG (237 kg) DP 3-,4-,5000-set based on solvents (alcohol and acetate), manufacturer Aarberg AG (200 kg) 13-set based on acetate, manufacturer Aarberg AG (1364 kg) CFA-set based on solvents, manufacturer Aarberg AG (99 kg) 19-set based on solvents, manufacturer Aarberg AG (1894 kg)	Input	Refined resource	Screen paint	3844			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: (Powder) Avskiktningsmedel Natrium-metaperjodat, manufacturer Edvars Schneidler.	Input	Refined resource	Seri strip SS-J41	12.5			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Manufacturer Edvard Schneidler	Input	Refined resource	Seriprep	0			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Rhodorsir (silicon), manufactured by MD Sveda	Input	Refined resource	Silikonemulsion	200			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Fixing consisting of ammonium sulphate and boric acid, held in a secluded system, manufactured by Stena Skanfors	Input	Refined resource	Snabbfix	80			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Cleaner Secluded recycling	Input	Refined resource	Stripp BR	2000			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Manufactured by Kebo Lab.	Input	Refined resource	Tetrahydrofuran	20			kg	Technosphere	
Notes: Where the thin polypropen amounts to 285000 m2.	Input	Refined resource	Unspecified	398000			m2	Technosphere	

Date concieved: 1996 Data type: Unspecified Notes: The UV-paint consist of: UV-paint/enamel, 78-set based on acrylate (5238 kg) 32-,33-,38-set based on acrylate (36 kg) 39-set based on acrylate (1347 kg) 40&41-set based on acrylate (200 kg) All paint is manufactured by Aarberg AG.	Input	Refined resource	UV paint	6821			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Cleaner	Input	Refined resource	UV-clean	100			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: 3 to 4 ton, where 2 ton is VOC.	Output	Emission	Solvents	3.5			tonne	Air	
Date concieved: 1996 Data type: Unspecified	Output	Residue	Corrugated cardboard	160			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: 5,2 ton metal scrap is recycled at the public cleansing department in Göteborg (fluorescent lamp and elektronics too), 555 kg plastics is recycled at the public cleansing department in Göteborg and 30,2 ton is combusted at the public cleansing department in Göteborg (rest products) och 128 kg paper shreds with solvents and paint, which Stena Miljö collects and SAKAB combusts.	Output	Residue	Industrial waste	35883			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Screen paint RECI/GRAAB disposes of the waste.	Output	Residue	Waste paint	388			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Paper from the office.	Output	Residue	Waste paper	650			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: RECI/GRAAB disposes of the waste.	Output	Residue	Waste perjod acid	570			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: RECI/GRAAB disposes of the waste.	Output	Residue	Waste solvents	2492			kg	Technosphere	

About Inventory

Publication	The environmental report from Strålfors Svenska AB for 1996, The Environmental Administration in the municipality of Göteborg -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Svensson Maria, Olsson Morgan - Strålfors Svenska AB Division Etikett Box 126 421 22 Västra Frölunda Sweden.
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	The extent of the production is not mentioned in the Environmental report. Because of this we have no functional unit which makes it impossible to use the data direct for life cycle analysis on one product. Though, it is possible to get in touch with the company and try to get some more information. The function of the system is described poorly and it is probably nessasary to contact the company for more information, if one wants to use the data.

About Data	
Notes	

SPINE LCI dataset: Production of Semichemical Fluting

Administrative	
Finished	Y
Date Completed	2000-01-18
Copyright	FEFCO, Groupement Ondulé, KRAFT Institute
Availability	The database is public and can be ordered without charge fro

Technical System	
Name	Production of Semichemical Fluting
Functional Unit	One ton of net saleable produced semichemical fluting
Functional Unit Explanation	Saleable means ready for delivery to customer.
Process Type	Gate to gate
Site	European average
Sector	Materials and components
Owner	European average

Technical system description	Semichemical Fluting is a component, the corrugated part, used for manufacturing of corrugated board. The Semichemical Fluting is made in a paper mill. These data are taken from ''European Database for Corrugated Board - Life Cycle Studies'' published by FEFCO, Groupement Ondulé and KRAFT Institute. These are the most resent data and are based on the year 1996. There will be an update in the year 2000 in which the data will be based on 1999. Only the processes within the mill are included. That is no transports to or from the mill are included. The forestry processes are not included. The raw material for Semichemical Fluting is wood, that is virgin fibres. Most of the wood is delivered to the mill in the form of pulpwood logs but a substantial part is brought to the mill as wood chips from saw mills. The pulpwood logs have to be debarked and chipped before further processing. Therefore logs pass through a barking drum and a chipper. The chips are then checked for oversized chips and other unwanted things. The oversized chips go through the chipper ones more. The chips are then stored in a chip pile before processing. The wood chips are cooked to pulp by the semichemical cooking process. It is a slightly alkaline cooking process with sodiumsulfite and sodiumcarbonate as active cooking chemicals. The pulp yield is normally around 80 %. The spent cooking liquor is drained off and washed out of the pulp. It contains wood substances as well as cooking chemicals. The liqour is concentrated and burnt for steam production and recovery of the cooking chemicals. The pulp is defiberized in refiners, screened and washed before being sent to the paper mill. The pulp is mechanical treated in beaters to improve fibre-to-fibre bonding and the strenght of the paper. The pH-level of the pulp slurry is adjusted with acid and some additives are added to facilitate the paper production. Finally the pulp slurry is screened and diluted before being sent to the head box of the paper machine. The paper is formed from the head box onto the wire and dewatered through the wire primarily by the action of gravity and suction. Since semichemical fluting is a paper with only one ply the paper machine has only one head box and one wire. Further dewatering by mechanical means take place in the press section where water is taken out of the sheet by pressing between felts. The final drying takes place in the drying section of the machine where the sheets run against heated cylinders to get its final dryness of 92%. The collected water is reused. After the paper machine there is a slitter winder where the big jumbo reel from the paper machine is rewound and cut down to customer reel formats according to customer orders. Finally the reels are weighted, marked, labelled and prepared for shipment to the customer, the corrugated board industry.

System Boundaries

Nature Boundary	Emissions from fuel combustion outside the mill is not included in the data. Emissions to air from the sites have been reported. Emissions from incineration of rejects with energy recovery at the mill are included. Emissions in the steam of the paper mill are not included. Emissions to air originating from the use of biogas from the mills anaerobic wastewater treatment are included. Water that is taken in has to be treated before it is used in the process, and it is again treated after the process before it is released as effluent to a recipient. The substances in the effluent after wastewater treatment are reported.
Time Boundary	The data are from 1996 and are the most resent ones. In the year 2000 there will be an update of the database which will be based on the year 1999.
Geographical Boundary	The data are valid for production of semichemical fluting in Europe they do not represent a specific plant but are average data from many plants all over Europe. The mills produce 80% of the semichemical fluting produced in Europe.
Other Boundaries	The production of raw material and resources is not included. Transports of raw materials, products and residues are not included.
Allocations	The system is considered as a closed loop system. This is not really true but is seen as a fairly good aproximation and is made to avoid allaocations. Within processes allocations has been made according to weight or according to the recipies for making the paper.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996-01-01
Data Type	Derived, statistics
Represents	European average
Method	The data are all taken from the Eropean Database for Corrugated Board-Life Cycle Studies
Literature Reference	European database for Corrugated Board-Life Cycle Studies

Notes	In this inventory profile it is possible to identify which process step (Rolled sheet production, Process scrap recycling) the flow is connected to and if it derives from the energy use, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: Average for Eurpean plants. Literature: European Database for Corrugated Board. Notes: Hardwood consists of: hardwood logs 0,77 ton hardwood chips 0,18 ton	Input	Natural resource	Hardwood	0.95			tonne	Forestral ground	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Method: Average for European plants Literature: Eurpoean Database for Corrugated Board. Notes: Sftwood contains of: softwood logs 0,06 ton softwood chips 0,03 ton	Input	Natural resource	Softwood	0.09			tonne	Forestral ground	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: Eurpean average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Bio fuels contain: bark: 190 MJ wood chips: 340MJ	Input	Refined resource	Bio fuel	530			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: packaging material	Input	Refined resource	Board	2.17			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Ca(OH)2, additive weight in dry mass	Input	Refined resource	Calciumhydroxide	1.3			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass	Input	Refined resource	CaO	0.3			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Coal	400			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: used to wind the fluting on material unknown, maybe wood	Input	Refined resource	Core and core plug	2.79			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: Composition not known. Weight of dry mass. additive	Input	Refined resource	Defoamer	0.13			kg	Technosphere	Europe

Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Diesel	50			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: This electricity is bought and not produced within the plant.	Input	Refined resource	Electricity	1520			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: H3PO4 weight in dry mass additive	Input	Refined resource	Fosforic acid	0.02			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass	Input	Refined resource	H2SO4	0.87			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Heavy oil	2900			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass HCl	Input	Refined resource	Hydrochloric acid	0.1			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: packaging material	Input	Refined resource	LDPE	0.07			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Light fuel oil	10			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass	Input	Refined resource	Lubricant	0.17			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass MgO	Input	Refined resource	Mangane oxide	1.0			kg	Technosphere	Europe

Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: soda additive weight in dry mass	Input	Refined resource	Na2CO3	2.1			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass	Input	Refined resource	NaOH	9.9			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Natural gas	1300			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass	Input	Refined resource	NH3	11.1			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass HNO3	Input	Refined resource	Nitric acid	0.06			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: Eurpean average Literature: Eurpean Database for Corrugated Board Notes: recovered paper of category: A: 0,08 ton D: 0,01 ton	Input	Refined resource	Other paper	0.09			tonne	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Input	Refined resource	Peat	2700			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass	Input	Refined resource	Pitch despergent	0.09			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: The pulp used is ''brown pulp''. The quantity is expressed in bone dry weight.	Input	Refined resource	Pulps	0.03			tonne	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass	Input	Refined resource	S	10			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle	Input	Refined resource	SO2	1.4			kg	Technosphere	Europe

Studies Notes: additive weight in dry mass									
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass	Input	Refined resource	Sodium chlorate	0.01			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: additive weight in dry mass	Input	Refined resource	Sodium sulphate	0.05			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: packaging material	Input	Refined resource	Steel	0.03			kg	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: European Database for Corrugated Board-Life Cycle Studies Notes: The electricity is sold to the public grid.	Output	By-product	Electricity	3			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: European Database for Corrugated Board-Life Cycle Studies Notes: The energy is sold.	Output	By-product	Thermal energy	410			MJ	Technosphere	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	BOD	1.3			kg	Water	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	CO	0.18			kg	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: fossil CO2: 533 kg biomass CO2: 580 kg	Output	Emission	CO2	1113			kg	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	COD	12.4			kg	Water	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	Dust	0.8			kg	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Emission	H2S	0.12			kg	Air	Europe

Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: counted as NO2	Output	Emission	NOx	1.5			kg	Air	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: counted as SO2	Output	Emission	SOx	5.3			kg	Air	Europe
	Output	Emission	Susp solids	2.2			kg	Water	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: European database for Corrugated Board-Life Cycle Studies Notes: Semichemical Fluting	Output	Product	Semichemical Fluting	1			tonne	Technosphere	World
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies	Output	Residue	Ashes	16.2			kg	Landfill ground	Europe
Date concieved: 1996-01-01 Data type: Derived, statistics Represents: European average Literature: Eropean Database for Corrugated Board-Life Cycle Studies Notes: this includes. inorganic sludge 2,4 kg organic sludge 17 kg paper related 0,9 kg other 2,7 kg	Output	Residue	Other rest products	23			kg	Landfill ground	Europe

About Inventory	
Publication	Published in the report ''European Database for Corrugated Board-Life Cycle Studies'' by FEFCO, Groupement Ondulé and KRAFT Institute in 1997. -- Data documented by: Åsa Ekdahl, M Sc. student at the dept. of Environmental Systems Analysis, Chalmers University of Technology and SKF Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	The intended users are practit
General Purpose	The purpose is to provide the industry and its customers the up-to-date knowledge, based on facts concerning the impact of the industry on the environment. Through this database the industry aims to make a contribution to the increasing need for basic environmental data for LCA studies, available in a transparent way.
Detailed Purpose	This data set has been documented for use in the study: ''LCA on SKF's Spherical Roller Bearing 24024''. The aim of the study is to descibe the environmental properties of the bearing as well as identify the processes contributing most to the environmental impact.
Commissioner	KRAFT Institute - Norrtullsgatan 43 S-113 45 Stockholm .
Practitioner	Manufacurers of Corrugated Board in Europe - .
Reviewer	
Applicability	The data can be used for the production of semichemical fluting in Europe that follow the process steps presented under ''Function''. The data are average for plants in Europe and do not represent a specific plant. Data for the production of Kraftliner and a Corrugated board box from the ''European Database for Corrugated Board-Life Cycle Studies'' is also available in SPINE@CPM. These activites are named: - Production of Kraftliner - Production of a Corrugated Board Box (182*62*182)
About Data	
Notes	The database will be updated in the year 2000 with data from the year 1999.

SPINE LCI dataset: Production of SKF Spherical Roller Bearing 232/530

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Production of SKF Spherical Roller Bearing 232/530
Functional Unit	One Spherical Roller Bearing (1204 kg Packed bearing)
Functional Unit Explanation	One Spherical Roller Bearing 232/530 (packed in a plywood box) manufactured at SKF in Göteborg, Sweden. The packed bearing weighs 1204 kg and the ingoing components are: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 rollers (coated or non-coated) 6. One plywood box. Dimensions of the bearing 232/530: di= 530 mm dy= 980 mm breadth= 355 mm The functional unit for this process is ONE SKF SRB 232/530. The activities for the production of the separate ingoing components are also available at SPINE@CPM: * Production of bearing rings * Production of brass cages used for spherical roller bearings * Production of guide rings used for spherical roller bearings * Production of bearing rollers (á 9.2 kg) * Production of plywood boxes
Process Type	Cradle to gate
Site	SKF Large Bearings
Sector	Materials and components
Owner	SKF Large Bearings
Technical system description	This life cycle assessment of spherical roller bearings is made at the request of SKF Industrial Division. This study is a case specific investigation of the production of spherical roller bearings produced at the production site of SKF Sverige AB in Göteborg, Sweden during the years 2000 - 2002. The spherical roller bearing 232/530 that is investigated in this report has the following components: -Inner ring 232/530 IR, 356 kg -Outer ring 232/530 OR, 387 kg -36 bearing rollers RS-232/530 C, 9.2 kg -Brass cage CS 232/530 CAM, 55.6 kg -Guide ring RG-232/530 C/243475, 9.6 kg and is packed in a plywood box, 52,61 kg. This dataset includes the following activities: 1. Production of brass cages used for spherical roller bearings 2. Production of bearing rollers (á 9.2 kg) 3. Production of bearing rings 4. Production of guide rings used for spherical roller bearings

	5. Production of plywood boxes 6. Production of Kraftliner 7. Extraction of crude oil 8. Refining of crude oil 9. Polyethylene (describing the production of Polyethylene) Detailed information about these subactivities can be obtained from SPINE@CPM. The assembly of the final product, the roller bearing 232/530, takes place at the C-factory at SKF in Göteborg, Sweden. All mounting is done by hand. As a last step before packing the bearing is treated in a rust protective bath. Then the bearing is packed in a plywood box together with rust protection paper (VPI paper) and plastic foil. The rust protection paper is in this study approximated with normal kraftliner, since the product contains 84% kraftliner. The data set for the production of Kraftliner has been obtained from the SPINE@CPM database. The supplier of the rust protection paper is Bröderna Ljungkvist AB and their production plant is located in Lich in Germany. The transport from Germany to SKF in Göteborg IS included in this study. The anti corrosive agent in the rust protection bath has been approximated with crude oil, and thus the activities 7 and 8 are included in this study. The LDPE foil is manufactured by TrioPlast AB in Smålandsstenar. Their subsupplier is located in Germany. For the production of polyethylene, a dataset from the SPINE@CPM database has been used(see Polyethylene). For more detailed information see the Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström; Chalmers University of Technology; December 2002.

System Boundaries

Nature Boundary	See each separate sub activity. The raw material for the bearing steel is scrap, which is regarded as a resource not traced back to the cradle. All resources except for the bearing steel and the casting iron, are assumed to be virgin ones, i e produced by non-recycled material. In many of the activities included in the life cycle steel scrap is produced. The steel scrap produced at SKF in Göteborg is transported to Ovako Steel in Hofors for recycling. For all activities at Ovako Steel in Hofors and at SKF Mekan in Katrineholm, steel scrap is described as co-product in the outflow, since the scrap is reused in their own processes. Also for the steel production in Sheffield (raw material for the rollers), steel scrap is considered as co-product in the outflow. The used bearings that are considered worn out are scrapped and the steel is recycled at Ovako Steel AB in Hofors. For further info see the Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström; Chalmers University of Technology; December 2002.
Time Boundary	The data was collected during the autumn 2002, and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The manufacturing of the bearing takes place at the SKF plant in Göteborg, Sweden.
Other Boundaries	All electricity production is included in the dataset. All production of other energy carriers like LPG, Fuel oil and Diesel is also included in the dataset. The transports from the suppliers to SKFs site in Göteborg and the diesel production for this are included. For detailed information about transports included see the Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström; Chalmers University of Technology; December 2002.
Allocations	Allocations have been made mainly according to weight. See under each separate acitivity. For detailed information see the Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström; Chalmers University of Technology; December 2002.
Systems Expansions	Not Applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	European average

Method	Data has preferably been collected from Environmental Reports and Safety Data Sheets. In some cases production data is monitored continually at the sites. The data from interviews with employees at the respective companies can be considered as expert out spokes. When data have not been available, persons familiar with the processes studied have made qualified estimations. Most data in the product system has been collected from specific sites and is therefore only valid for these. They can be used as approximations for other systems with care. Some components are produced abroad and data has then been collected from these specific sites. If no data was available from the specific sites, average production data from different databases (mostly CIT Ekologik AB and SPINE at CPM) has been used for the activities. This is described in detail for each activity available in the SPINE@CPM database.
Literature Reference	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002.
Notes	In this inventory profile it is possible to identify which process step (Rolled sheet production, Process scrap recycling) the flow is connected to and if it derives from the energy use, see Note-field for each specific flow. However, in order to get the numerical data devided on these two process steps, see Environmental Profile Report (EAA, 2000).

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Ground water	1.098e-005			kg	Ground	
	Input	Natural resource	Sea water	0.01386			kg	Ground	
	Input	Natural resource	Sea water	26.81			kg	Water	
	Input	Natural resource	Surface water	1562			kg	Water	
	Input	Natural resource	Surface water	2.24e-007			kg	Ground	
	Input	Refined resource	Absol	0.01178			kg	Technosphere	
	Input	Refined resource	Air	867.8			kg	Air	
	Input	Refined resource	Al	0.001005			kg	Technosphere	
	Input	Refined resource	Al	2.942			kg	Ground	
	Input	Refined resource	Al2(SO4)3	0.01766			kg	Technosphere	
	Input	Refined resource	Alloy ore	0.06939			kg	Other	
	Input	Refined resource	Alumet	5.601			kg	Technosphere	
	Input	Refined resource	Aluminium	0.0004709			kg	Technosphere	
	Input	Refined resource	Aluminium hydroxide	0.0002751			kg	Technosphere	
	Input	Refined resource	Aluminium oxide	0.003068			kg	Technosphere	
	Input	Refined resource	Antifoam SE	1.129e-005			m3	Technosphere	
	Input	Refined resource	Ba	0.001005			kg	Technosphere	
	Input	Refined resource	Bark	1.713			MJ	Technosphere	
	Input	Refined resource	Bauxite	0.003312			kg	Technosphere	
	Input	Refined resource	Bauxite	0.03749			kg	Other	
	Input	Refined resource	Bauxite	18.72			kg	Ground	
	Input	Refined resource	Bentonite	0.03369			kg	Other	
	Input	Refined resource	Bentonite	0.04917			kg	Ground	
	Input	Refined resource	biocides	0.0002108			kg	Technosphere	
	Input	Refined resource	Biomass	0.1604			kg	Technosphere	
	Input	Refined resource	Biomass	41.23			kg	Ground	
	Input	Refined resource	BL AIR set	0.004804			kg	Technosphere	

	Input	Refined resource	Blast furnace gas	1.187			MJ	Technosphere	
	Input	Refined resource	Blasting grit	0.08437			kg	Technosphere	
	Input	Refined resource	Board	0.0001318			kg	Technosphere	
	Input	Refined resource	Bonder 202A	0.006779			kg	Technosphere	
	Input	Refined resource	Bonder 202E	0.02034			kg	Technosphere	
	Input	Refined resource	Brick	0.4761			kg	Technosphere	
	Input	Refined resource	Briquets (recycled material)	0.04289			kg	Technosphere	
	Input	Refined resource	Ca	0.001005			kg	Technosphere	
	Input	Refined resource	CaCO3	0.007642			kg	Technosphere	
	Input	Refined resource	Calcium fluoride	0.0005972			kg	Technosphere	
	Input	Refined resource	Calcium sulphate	0.4106			kg	Ground	
	Input	Refined resource	Caliche	1.076			kg	Ground	
	Input	Refined resource	CaO	0.0108			kg	Technosphere	
	Input	Refined resource	Carbon	0.4395			kg	Technosphere	
	Input	Refined resource	Carbon	45.58			kg	Ground	
	Input	Refined resource	Chalice	0.008645			kg	Other	
	Input	Refined resource	Chalk	0.0008274			kg	Ground	
	Input	Refined resource	Chromium	0.01658			kg	Ground	
	Input	Refined resource	Clay	0.1973			kg	Ground	
	Input	Refined resource	Coal	2.861			kg	Other	
	Input	Refined resource	Coke dust	3.342			kg	Technosphere	
	Input	Refined resource	Coke gas	0.5931			MJ	Technosphere	
	Input	Refined resource	Copper in ore	0.03084			kg	Ground	
	Input	Refined resource	Core and core plug	0.005033			kg	Technosphere	
	Input	Refined resource	Crude oil	0.0001388			kg	Technosphere	
	Input	Refined resource	Crude oil	2.352			MJ	Technosphere	
	Input	Refined resource	Crude oil	670.6			kg	Ground	
	Input	Refined resource	Crude oil, feedstock	0.01066			kg	Ground	
	Input	Refined resource	Cu	0.02356			kg	Technosphere	
	Input	Refined resource	Defoamers	0.002503			kg	Technosphere	
	Input	Refined resource	Diesel	0.000271			kg	Other	
	Input	Refined resource	Dimatrenn SL	9.014e-008			m3	Technosphere	
	Input	Refined resource	DMSO	0.01365			kg	Technosphere	
	Input	Refined resource	Dolomite	0.1428			kg	Technosphere	
	Input	Refined resource	Dolomite	0.7056			kg	Ground	
	Input	Refined resource	Dolomite	3.497e-006			kg	Other	
	Input	Refined resource	Drivibe 400 Z	0.0273			kg	Technosphere	

	Input	Refined resource	Electricity	0.004924			MJ	Other	
	Input	Refined resource	Electricity	11.12			MJ	Technosphere	
	Input	Refined resource	Electrode	6.851			kg	Technosphere	
	Input	Refined resource	Emulsifier	5.621e-005			kg	Other	
	Input	Refined resource	Emulsifying agent	0.007019			kg	Technosphere	
	Input	Refined resource	Emulsion	2.609			kg	Technosphere	
	Input	Refined resource	Explosives	3.592e-007			kg	Technosphere	
	Input	Refined resource	Feldspar	0.000933			kg	Ground	
	Input	Refined resource	Feldspar	2.586e-006			kg	Other	
	Input	Refined resource	Fe-pellets	1.375			kg	Technosphere	
	Input	Refined resource	Ferric oxide	0.0002561			kg	Technosphere	
	Input	Refined resource	Ferro Molybdenum (FeMo)	1.41			kg	Technosphere	
	Input	Refined resource	Ferro Sulphur (FeS)	0.544			kg	Technosphere	
	Input	Refined resource	Ferroboron (FeB)	0.00131			kg	Technosphere	
	Input	Refined resource	Ferrochromium (FeCr)	28.01			kg	Technosphere	
	Input	Refined resource	Ferromanganese	0.03375			kg	Technosphere	
	Input	Refined resource	Ferromanganese	0.03399			kg	Ground	
	Input	Refined resource	Ferromanganese in ore	7.717			kg	Technosphere	
	Input	Refined resource	Ferroniobium (FeNb)	0.002418			kg	Technosphere	
	Input	Refined resource	Ferrosilicon (FeSi)	8.583			kg	Technosphere	
	Input	Refined resource	Ferrotitanium (FeTi)	0.008059			kg	Technosphere	
	Input	Refined resource	Ferrovanadium (FeV)	0.141			kg	Technosphere	
	Input	Refined resource	FeS	0.006658			kg	Technosphere	
	Input	Refined resource	Fluorspar	0.3368			kg	Ground	
	Input	Refined resource	Forest land	112.8			m2 year	Ground	
	Input	Refined resource	Fuel oil	0.233			kg	Other	
	Input	Refined resource	Gardorol CP 8010	4.744e-005			m3	Technosphere	
	Input	Refined resource	Gasoline	0.004883			MJ	Technosphere	
	Input	Refined resource	Gravel	0.1396			kg	Ground	
	Input	Refined resource	Grease	0.2765			kg	Technosphere	
	Input	Refined resource	grinding plates	0.0144			m	Technosphere	
	Input	Refined resource	H2O	0.01229			kg	Ground	
	Input	Refined resource	H2O	0.05326			m3	Technosphere	
	Input	Refined resource	H2O	6.793			kg	Water	
	Input	Refined resource	H2SO4	0.03874			kg	Technosphere	
	Input	Refined resource	Hard coal	458.1			kg	Ground	
	Input	Refined resource	Hard coal, feedstock	0.002196			kg	Ground	

	Input	Refined resource	Hard coal, feedstock	31.77			MJ	Technosphere	
	Input	Refined resource	Hardwood	0.1845			kg	Ground	
	Input	Refined resource	HCl	0.00731			kg	Technosphere	
	Input	Refined resource	Heat	3.51			MJ	Technosphere	
	Input	Refined resource	Heavy fuel oil, feedstock	1.363			MJ	Technosphere	
	Input	Refined resource	Hg	8.194e-008			kg	Technosphere	
	Input	Refined resource	Hydraulic Oil	0.0005659			m3	Technosphere	
	Input	Refined resource	Hydraulic Oil	1.109			kg	Technosphere	
	Input	Refined resource	Hydro power	0.002259			kg	Ground	
	Input	Refined resource	Hydro power	0.003512			kg	Other	
	Input	Refined resource	Hydro power	7852			MJ	Ground	
	Input	Refined resource	Hydrochloric acid	0.0001845			kg	Technosphere	
	Input	Refined resource	Hyspin AWS 46	2.1e-005			m3	Technosphere	
	Input	Refined resource	Ingot Mould	20.35			kg	Technosphere	
	Input	Refined resource	Iron	0.0004927			kg	Technosphere	
	Input	Refined resource	Iron	37.47			kg	Ground	
	Input	Refined resource	Iron in ore	0.1522			kg	Ground	
	Input	Refined resource	Iron ore	0.002208			kg	Technosphere	
	Input	Refined resource	Iron ore	10.66			kg	Other	
	Input	Refined resource	Iron ore	5.121			kg	Ground	
	Input	Refined resource	Isofrax	2.827e-006			m2	Technosphere	
	Input	Refined resource	Kermag EN 95	2.883e-005			kg	Technosphere	
	Input	Refined resource	Land use	0.01623			m2 year	Ground	
	Input	Refined resource	LD-slag	0.03688			kg	Technosphere	
	Input	Refined resource	Lead	0.001262			kg	Ground	
	Input	Refined resource	Lead in ore	0.000548			kg	Ground	
	Input	Refined resource	Lead in ore	4.1			kg	Technosphere	
	Input	Refined resource	Light fuel oil	0.1591			MJ	Technosphere	
	Input	Refined resource	Lignite	94.39			kg	Ground	
	Input	Refined resource	Lime	0.2061			kg	Technosphere	
	Input	Refined resource	Lime	4.962e-006			kg	Other	
	Input	Refined resource	Lime	55.97			kg	Ground	
	Input	Refined resource	Limestone	0.001656			kg	Technosphere	
	Input	Refined resource	Limestone	0.504			kg	Other	
	Input	Refined resource	Limestone	53.67			kg	Ground	
	Input	Refined resource	Lubricant	0.0004743			kg	Technosphere	
	Input	Refined resource	Lubricating Oil	0.0001884			m3	Technosphere	

	Input	Refined resource	Lubricating Oil	0.254			kg	Technosphere	
	Input	Refined resource	Magna BD 68	0.0004219			m3	Technosphere	
	Input	Refined resource	Magnetic powder	0.02917			kg	Technosphere	
	Input	Refined resource	Manganese	2.871e-006			kg	Technosphere	
	Input	Refined resource	Merchant Scrap	1458			kg	Technosphere	
	Input	Refined resource	Metal Ribbon	1.962			kg	Technosphere	
	Input	Refined resource	Methanol	5.22			kg	Technosphere	
	Input	Refined resource	Municipal water	158.5			kg	Technosphere	
	Input	Refined resource	Municipal water	31.29			kg	Water	
	Input	Refined resource	Municipal water	8.34e-005			m3	Technosphere	
	Input	Refined resource	N2	91			kg	Technosphere	
	Input	Refined resource	Na2CO3	0.005007			kg	Technosphere	
	Input	Refined resource	Na2SO4	0.005007			kg	Technosphere	
	Input	Refined resource	Na2SO4	9.11e-005			kg	Other	
	Input	Refined resource	NaCl	0.07728			kg	Technosphere	
	Input	Refined resource	NaOH	0.02451			kg	Technosphere	
	Input	Refined resource	Natural gas	0.02411			kg	Other	
	Input	Refined resource	Natural gas	76.43			kg	Ground	
	Input	Refined resource	Natural gas, feedstock	4.795			MJ	Technosphere	
	Input	Refined resource	Ni	2.015			kg	Ground	
	Input	Refined resource	Nitrogen	0.4444			kg	Ground	
	Input	Refined resource	NO3-N	0.2334			kg	Other	
	Input	Refined resource	O2	15.13			kg	Technosphere	
	Input	Refined resource	Oil	0.001794			kg	Technosphere	
	Input	Refined resource	Oil	0.004497			kg	Other	
	Input	Refined resource	Oil	46.57			MJ	Technosphere	
	Input	Refined resource	Olivine	13.72			kg	Ground	
	Input	Refined resource	Other fuel	470.3			MJ	Technosphere	
	Input	Refined resource	Oxygen	3.49e-011			m3	Technosphere	
	Input	Refined resource	Oxygen	67.18			kg	Ground	
	Input	Refined resource	Oxygen	93.29			kg	Technosphere	
	Input	Refined resource	Peat	0.002324			kg	Ground	
	Input	Refined resource	Peat	0.00276			kg	Other	
	Input	Refined resource	Peat	0.04849			kg	Technosphere	
	Input	Refined resource	Peat	0.1581			MJ	Technosphere	
	Input	Refined resource	Phenol	0.01237			kg	Technosphere	
	Input	Refined resource	Pitch despergent	5.27e-005			kg	Technosphere	

	Input	Refined resource	Plaster	0.01024			kg	Technosphere	
	Input	Refined resource	Polymers	1.969e-006			m3	Technosphere	
	Input	Refined resource	Portland soda	4.071e-006			kg	Other	
	Input	Refined resource	Potassium Hydroxide	0.116			kg	Technosphere	
	Input	Refined resource	Potassium nitrate	3.528			kg	Technosphere	
	Input	Refined resource	Potassium oxide	0.0006811			kg	Technosphere	
	Input	Refined resource	Propane	0.7832			kg	Technosphere	
	Input	Refined resource	Propene	0.01229			kg	Technosphere	
	Input	Refined resource	Public supply	5806			kg	Water	
	Input	Refined resource	Quartz	0.2286			kg	Ground	
	Input	Refined resource	R03	1.055e-007			m3	Technosphere	
	Input	Refined resource	Recovered energy	-228.8			MJ	Technosphere	
	Input	Refined resource	Recycled iron	28.01			kg	Technosphere	
	Input	Refined resource	Refractory Lining	21.96			kg	Technosphere	
	Input	Refined resource	Refractory materials	0.0002022			kg	Technosphere	
	Input	Refined resource	Renewable energy source	0.01524			kg	Other	
	Input	Refined resource	Renewable fuel	337.7			MJ	Technosphere	
	Input	Refined resource	Retention aids	0.001502			kg	Technosphere	
	Input	Refined resource	Rimitanol TFA17	6.779e-006			m3	Technosphere	
	Input	Refined resource	S	0.000448			kg	Technosphere	
	Input	Refined resource	Sand	2.853e-005			kg	Other	
	Input	Refined resource	Sand	283.1			kg	Ground	
	Input	Refined resource	Saw Blade	0.08081			kg	Technosphere	
	Input	Refined resource	Shale	1.168			kg	Ground	
	Input	Refined resource	Si	0.06294			kg	Technosphere	
	Input	Refined resource	SiC	0.3713			kg	Technosphere	
	Input	Refined resource	Silicon dioxide	0.0128			kg	Technosphere	
	Input	Refined resource	Sizing agents	0.004216			kg	Technosphere	
	Input	Refined resource	Slag	0.004981			kg	Technosphere	
	Input	Refined resource	Sodium carbonate	0.001474			kg	Ground	
	Input	Refined resource	Sodium chloride	2.809			kg	Ground	
	Input	Refined resource	Sodium hydroxide	0.003559			kg	Technosphere	
	Input	Refined resource	Sodium nitrite	3.528			kg	Technosphere	
	Input	Refined resource	Sodium oxide	0.0006811			kg	Technosphere	
	Input	Refined resource	Sodium sulphate	7.618e-005			kg	Technosphere	
	Input	Refined resource	Softwood	3.334			kg	Ground	
	Input	Refined resource	Soil and loose earth material	0.0002208			kg	Technosphere	

	Input	Refined resource	Solvey soda	0.001474			kg	Technosphere	
	Input	Refined resource	Solvey soda	4.071e-006			kg	Other	
	Input	Refined resource	Starch	0.01107			kg	Technosphere	
	Input	Refined resource	Steam	0.01795			MJ	Technosphere	
	Input	Refined resource	Steam	82.61			kg	Technosphere	
	Input	Refined resource	Steel	0.1086			kg	Technosphere	
	Input	Refined resource	Steel scrap	810.8			kg	Technosphere	
	Input	Refined resource	Sulphur	0.002218			kg	Technosphere	
	Input	Refined resource	Sulphur (bonded)	0.1411			kg	Ground	
	Input	Refined resource	Sulphur (elemental)	0.2856			kg	Ground	
	Input	Refined resource	Sulphuric acid	0.3457			kg	Technosphere	
	Input	Refined resource	SW 8571	1.055e-006			m3	Technosphere	
	Input	Refined resource	Technical white	6.328e-006			m3	Technosphere	
	Input	Refined resource	Teeming Channel Bricks	8.563			kg	Technosphere	
	Input	Refined resource	Thermal energy	0.9311			MJ	Technosphere	
	Input	Refined resource	Tools	3.833			kg	Technosphere	
	Input	Refined resource	Triacetin	0.2253			kg	Technosphere	
	Input	Refined resource	Trietanolamin	5.56e-005			m3	Technosphere	
	Input	Refined resource	Unspecified	4.129e+004			kg	Water	
	Input	Refined resource	Unspecified fuel	0.002202			MJ	Ground	
	Input	Refined resource	Uranium	4.109e-006			kg	Other	
	Input	Refined resource	Uranium in ore	0.06561			kg	Ground	
	Input	Refined resource	Uranium ore	3.546e-005			kg	Ground	
	Input	Refined resource	Waste paper	0.6061			kg	Technosphere	
	Input	Refined resource	Water	0.01039			kg	Other	
	Input	Refined resource	Water	198.7			kg	Technosphere	
	Input	Refined resource	Water	6.61e+004			kg	Ground	
	Input	Refined resource	Water	85.42			kg	Water	
	Input	Refined resource	Wind power	16.03			MJ	Ground	
	Input	Refined resource	Wood	0.02335			kg	Ground	
	Input	Refined resource	Wood	484.8			MJ	Technosphere	
	Input	Refined resource	Wood chips	48.43			kg	Ground	
	Input	Refined resource	Wood Packing	51.95			kg	Technosphere	
	Input	Refined resource	Ytex 1610	0.04293			kg	Technosphere	
	Input	Refined resource	Zinc	1.321			kg	Ground	
	Input	Refined resource	Zinc in ore	73.37			kg	Ground	
	Input	Refined resource	Zn	0.21			kg	Ground	

	Output	Co-product	Benzene	0.00967			kg	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Co-product	Blast furnace gas	1.469			Nm3	Technosphere	
	Output	Co-product	Brass	149.4			kg	Technosphere	Sweden
	Output	Co-product	Carbon reused as fuel	0.0003903			kg	Technosphere	
	Output	Co-product	Coke dust	0.06499			kg	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Co-product	Coke gas	0.06499			Nm3	Technosphere	
	Output	Co-product	Drinking Water	116.1			kg	Technosphere	Sweden
	Output	Co-product	Electricity	0.01845			MJ	Technosphere	
	Output	Co-product	Gasoline	36.55			MJ	Technosphere	
	Output	Co-product	Iron scrap	24.15			kg	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Co-product	LD-gas	0.1517			Nm3	Technosphere	
	Output	Co-product	Pig iron	0.05127			kg	Technosphere	
	Output	Co-product	Raw steel	0.2819			kg	Technosphere	
	Output	Co-product	Recycled steel	526.6			kg	Technosphere	
	Output	Co-product	SO2	60.29			kg	Technosphere	
	Output	Co-product	Steam	0.9578			MJ	Technosphere	
	Output	Co-product	Steel scrap	183.4			kg	Technosphere	
	Output	Co-product	Sulphur	0.001823			kg	Technosphere	
	Output	Co-product	Tall oil	0.06588			kg	Technosphere	
	Output	Co-product	Tar	0.03346			kg	Technosphere	
	Output	Co-product	Thermal energy	0.8433			MJ	Technosphere	
	Output	Co-product	Turpentine	0.003426			kg	Technosphere	
	Output	Emission	Acetaldehyde	2.015e-007			kg	Air	
	Output	Emission	Acetylene	0.0007492			kg	Air	
	Output	Emission	Acid as H+	0.001685			kg	Water	
	Output	Emission	Acidification eq	0.0007728			kg	Water	
	Output	Emission	Aerosols	0.0009197			kg	Air	
	Output	Emission	Al	0.0009896			kg	Water	
	Output	Emission	Aldehydes	6.482e-005			kg	Air	
	Output	Emission	Aliphatic HC	0.001117			kg	Air	
	Output	Emission	Alkanes	0.0008557			kg	Air	
	Output	Emission	Alkenes	0.0007546			kg	Air	
	Output	Emission	Aromates (C9-C10)	0.0001724			kg	Air	
	Output	Emission	Aromates (C9-C10)	4.563e-005			kg	Water	
	Output	Emission	Aromatics	2.826e-007			kg	Water	
	Output	Emission	As	0.03246			kg	Air	
	Output	Emission	As	7.102e-005			kg	Water	
	Output	Emission	Ashes	2.12			kg	Air	
	Output	Emission	B	0.002982			kg	Air	
	Output	Emission	Be	1.048e-005			kg	Air	
	Output	Emission	Benzene	0.01723			kg	Air	
	Output	Emission	Benzo(a)pyrene	4.762e-008			kg	Air	
	Output	Emission	BOD	0.5576			kg	Water	
	Output	Emission	BOD5	0.000108			kg	Water	
	Output	Emission	BOD-7	7.49e-006			kg	Water	
	Output	Emission	Butane	0.0001416			kg	Air	
	Output	Emission	Ca	1.394e-005			kg	Air	
	Output	Emission	Ca2+	0.1236			kg	Water	
	Output	Emission	Cd	0.006282			kg	Air	
	Output	Emission	Cd	3.461e-005			kg	Water	
	Output	Emission	CH4	0.01275			kg	Air	
	Output	Emission	Chloride	0.001326			kg	Water	
	Output	Emission	Cl-	137.7			kg	Water	
	Output	Emission	CN-	0.0001642			kg	Air	
	Output	Emission	CN-	5.725e-006			kg	Water	
	Output	Emission	CN total	5.441e-007			kg	Water	

	Output	Emission	Co	0.0001735			kg	Air	
	Output	Emission	Co	1.484e-006			kg	Water	
	Output	Emission	CO	8.03			kg	Air	
	Output	Emission	CO2	3756			kg	Air	
	Output	Emission	CO32-	0.001396			kg	Water	
	Output	Emission	COD	0.7212			kg	Water	
	Output	Emission	COS	9.401e-005			kg	Air	
	Output	Emission	Cr	0.0009345			kg	Air	
	Output	Emission	Cr	1.824e-005			kg	Water	
	Output	Emission	Cr3+	0.0004967			kg	Water	
	Output	Emission	Cr3+	4.473e-005			kg	Air	
	Output	Emission	CS2	0.01386			kg	Air	
	Output	Emission	Cu	0.1138			kg	Air	
	Output	Emission	Cu	6.653e-006			kg	Water	
	Output	Emission	Cu2+	0.005143			kg	Water	
	Output	Emission	Cyanide	1.419e-008			kg	Water	
	Output	Emission	Dioxin	2.555e-009			kg	Air	
	Output	Emission	Dioxin (TCDD)	2.619e-009			kg	Air	
	Output	Emission	Dissolved organic carbon	1.594e-012			kg	Water	
	Output	Emission	Dissolved organics	0.0002208			kg	Water	
	Output	Emission	Dissolved solids	266.1			kg	Water	
	Output	Emission	Dust	15.06			kg	Air	
	Output	Emission	Emulsion	2.609			kg	Water	
	Output	Emission	Ethane	0.002248			kg	Air	
	Output	Emission	Ethene	0.004495			kg	Air	
	Output	Emission	F-	0.01451			kg	Water	
	Output	Emission	F-	2.257e-005			kg	Air	
	Output	Emission	F total	2.351e-008			kg	Water	
	Output	Emission	Fe	0.0009855			kg	Air	
	Output	Emission	Fe	0.1221			kg	Water	
	Output	Emission	Fluorides	3.764e-009			kg	Air	
	Output	Emission	Fluorides	5.079e-007			kg	Water	
	Output	Emission	Formaldehyde	0.0002184			kg	Air	
	Output	Emission	H2	0.5375			kg	Air	
	Output	Emission	H2S	0.000496			kg	Air	
	Output	Emission	H2S	1.877e-007			kg	Water	
	Output	Emission	H2SO4	1.881e-005			kg	Water	
	Output	Emission	HC	0.001104			kg	Water	
	Output	Emission	HC	0.2339			kg	Air	
	Output	Emission	HCl	0.2992			kg	Air	
	Output	Emission	Heavy metals	7.182e-018			kg	Air	
	Output	Emission	Hexafluoroethane	9.401e-007			kg	Air	
	Output	Emission	HF	0.02172			kg	Air	
	Output	Emission	Hg	0.000623			kg	Air	
	Output	Emission	Hg	2.832e-011			kg	Water	
	Output	Emission	HNO3	1.729e-005			kg	Water	
	Output	Emission	Hydrocarbons	0.0001423			kg	Water	
	Output	Emission	Hydrocarbons	0.1414			kg	Air	
	Output	Emission	Iron	3.603e-007			kg	Water	
	Output	Emission	Metals	0.0007695			kg	Air	
	Output	Emission	Metals	0.005115			kg	Water	
	Output	Emission	Methane	6.721			kg	Air	
	Output	Emission	Mg	0.0008792			kg	Air	
	Output	Emission	Mn	0.0002171			kg	Water	
	Output	Emission	Mn	0.0005978			kg	Air	
	Output	Emission	Mo	0.0001357			kg	Air	
	Output	Emission	N total	0.07034			kg	Water	
	Output	Emission	N2	82.61			kg	Air	
	Output	Emission	N2O	0.01814			kg	Air	
	Output	Emission	Na	0.0001306			kg	Air	
	Output	Emission	Na+	0.006412			kg	Water	
	Output	Emission	NaCl	4.303e-007			kg	Water	
	Output	Emission	NH3	0.0004737			kg	Air	
	Output	Emission	NH3	6.548e-005			kg	Water	

	Output	Emission	NH4+	0.007152			kg	Water	
	Output	Emission	NH4+ as N	0.001002			kg	Water	
	Output	Emission	NH4-N	3.454e-005			kg	Water	
	Output	Emission	NH4NO3	0.0003443			kg	Air	
	Output	Emission	NH4NO3	1.004e-005			kg	Water	
	Output	Emission	Ni	0.0002367			kg	Water	
	Output	Emission	Ni	0.002668			kg	Air	
	Output	Emission	Ni2+	0.004846			kg	Water	
	Output	Emission	Nitrogen	9.993e-005			kg	Water	
	Output	Emission	NMVOC	0.5709			kg	Air	
	Output	Emission	NMVOC, diesel engines	0.03084			kg	Air	
	Output	Emission	NMVOC, natural gas combustion	0.003781			kg	Air	
	Output	Emission	NMVOC, oil combustion	4.804			kg	Air	
	Output	Emission	NMVOC, petrol engines	2.276e-012			kg	Air	
	Output	Emission	NMVOC, power plants	0.007388			kg	Air	
	Output	Emission	NO2-	9.055e-007			kg	Water	
	Output	Emission	NO2-N	2.179e-006			kg	Water	
	Output	Emission	NO3-	0.0499			kg	Water	
	Output	Emission	NO3- as N	1.587e-006			kg	Water	
	Output	Emission	NOx	28.94			kg	Air	
	Output	Emission	N-tot	0.0002809			kg	Water	
	Output	Emission	Oil	0.579			kg	Water	
	Output	Emission	Oil	2.153e-005			kg	Air	
	Output	Emission	Olivine	1.411e-005			kg	Water	
	Output	Emission	Organic compounds	5.52e-005			kg	Air	
	Output	Emission	Organics	4.701e-008			kg	Water	
	Output	Emission	Other organics	0.04479			kg	Air	
	Output	Emission	Other organics	0.4444			kg	Water	
	Output	Emission	P total	2.111e-005			kg	Water	
	Output	Emission	PAH	4.437e-006			kg	Air	
	Output	Emission	PAH	4.701e-007			kg	Water	
	Output	Emission	Particles	3.644e-006			kg	Water	
	Output	Emission	Particles	55.65			kg	Air	
	Output	Emission	Particulates	1.958e-005			kg	Air	
	Output	Emission	Pb	0.02023			kg	Water	
	Output	Emission	Pb	0.8632			kg	Air	
	Output	Emission	Pentane	0.0002427			kg	Air	
	Output	Emission	Phenol	1.146e-007			kg	Air	
	Output	Emission	Phenol	1.197e-005			kg	Water	
	Output	Emission	Phosphorus	0.0003729			kg	Air	
	Output	Emission	PO43-	0.001719			kg	Water	
	Output	Emission	Potassium nitrate	0.7949			kg	Water	
	Output	Emission	Propane	0.001544			kg	Air	
	Output	Emission	Propene	0.0007493			kg	Air	
	Output	Emission	P-tot	5.732e-005			kg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	1.03e+012			Bq	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radioactive	9.672e+009			Bq	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radon-222	957.5			Bq	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Rn-222	2.138e+008			Bq	Air	
	Output	Emission	S2-	1.131			kg	Water	

	Output	Emission	Sb	2.049e-008			kg	Water	
	Output	Emission	Sb	7.571e-005			kg	Air	
	Output	Emission	Se	0.0001044			kg	Air	
	Output	Emission	Sn	0.001608			kg	Water	
	Output	Emission	Sn	6.812e-007			kg	Air	
	Output	Emission	SO2	7.41			kg	Air	
	Output	Emission	SO4 2-	0.001407			kg	Water	
	Output	Emission	SO42-	47.42			kg	Water	
	Output	Emission	Sodium chloride	0.2904			kg	Water	
	Output	Emission	Sodium nitrite	0.7949			kg	Water	
	Output	Emission	SOx	144.5			kg	Air	
	Output	Emission	Sr	0.001239			kg	Water	
	Output	Emission	Sr	3.069e-005			kg	Air	
	Output	Emission	Sulphates	0.0001104			kg	Water	
	Output	Emission	Sulphur	0.4958			kg	Air	
	Output	Emission	Susp solids	0.01106			kg	Water	
	Output	Emission	Suspended solids	11.27			kg	Water	
	Output	Emission	Suspended solids	2.87e-007			kg	Air	
	Output	Emission	Tetrafluoromethane	8.464e-006			kg	Air	
	Output	Emission	Th	4.875e-007			kg	Air	
	Output	Emission	Tl	8.401e-008			kg	Air	
	Output	Emission	Toluene	0.0001956			kg	Air	
	Output	Emission	Total organic carbon	1.373e-007			kg	Water	
	Output	Emission	Tot-CN	1.314e-006			kg	Water	
	Output	Emission	U	4.679e-007			kg	Air	
	Output	Emission	V	0.001729			kg	Air	
	Output	Emission	V	4.822e-006			kg	Water	
	Output	Emission	VOC	0.1632			kg	Air	
	Output	Emission	VOC, coal combustion	0.0003463			kg	Air	
	Output	Emission	VOC, diesel engines	0.008435			kg	Air	
	Output	Emission	VOC, natural gas combustion	2.38e-011			kg	Air	
	Output	Emission	Xylene	0.0001498			kg	Air	
	Output	Emission	Zn	0.0003479			kg	Water	
	Output	Emission	Zn	0.8058			kg	Air	
	Output	Emission	Zn2+	0.00344			kg	Water	
	Output	Product	Packed bearing	1204			kg	Technosphere	
	Output	Residue	As	4.23e-006			kg	Technosphere	
	Output	Residue	Ashes	0.09149			kg	Technosphere	
	Output	Residue	Blasting grit	0.08437			kg	Ground	
	Output	Residue	Brick	0.062			kg	Technosphere	
	Output	Residue	Bulky	130.1			kg	Technosphere	
	Output	Residue	Carbon	0.0001787			kg	Technosphere	
	Output	Residue	Cd	1.224e-005			kg	Technosphere	
	Output	Residue	Chemicals	0.0009766			kg	Technosphere	
	Output	Residue	Co	3.682e-006			kg	Technosphere	
	Output	Residue	Cr	2.684e-005			kg	Technosphere	
	Output	Residue	Cu	7.477e-005			kg	Technosphere	
	Output	Residue	Demolition	0.1441			kg	Technosphere	
	Output	Residue	Disposal waste	0.00894			kg	Technosphere	
	Output	Residue	Disposal waste	0.02888			kg	Ground	
	Output	Residue	Dolomite	0.01126			kg	Technosphere	
	Output	Residue	Dross fines	4.936e-005			kg	Technosphere	
	Output	Residue	Emulsion	0.382			kg	Technosphere	
	Output	Residue	glugol	0.0009372			kg	Technosphere	
	Output	Residue	Granite	2.347			kg	Technosphere	
	Output	Residue	Grease	0.001847			kg	Technosphere	
	Output	Residue	Grease	0.1616			kg	Technosphere	
	Output	Residue	Grindings	33.92			kg	Technosphere	
	Output	Residue	Hazardous	22.29			kg	Technosphere	
	Output	Residue	Hazardous waste	0.1575			kg	Technosphere	
	Output	Residue	Highly active rad ac waste	2.761e-011			kg	Ground	
	Output	Residue	Highly radioactive	0.0149			cm3	Ground	
	Output	Residue	Highly radioactive	0.09415			kg	Technosphere	
	Output	Residue	Highly radioactive	9.455e-010			kg	Ground	

	Output	Residue	Hydraulic Oil	1.108			kg	Technosphere	
	Output	Residue	Industrial	190.4			kg	Technosphere	
	Output	Residue	Industrial waste	0.03422			kg	Technosphere	
	Output	Residue	Inert chemicals	0.05611			kg	Technosphere	
	Output	Residue	Inert residues	0.00256			kg	Technosphere	
	Output	Residue	Ingot Mould	20.35			kg	Technosphere	
	Output	Residue	krymp och sträckfilm	0.001383			kg	Technosphere	
	Output	Residue	LD-dust	0.0009567			kg	Technosphere	
	Output	Residue	LD-slag	0.05476			kg	Technosphere	
	Output	Residue	LD-sludge	0.04332			kg	Technosphere	
	Output	Residue	Low radioactive	0.1698			cm3	Ground	
	Output	Residue	Lubricating Oil	0.254			kg	Technosphere	
	Output	Residue	Medium radioactive	0.1698			cm3	Ground	
	Output	Residue	Medium radioactive	5.156e-009			kg	Ground	
	Output	Residue	Metal Ribbon	1.962			kg	Technosphere	
	Output	Residue	Mineral	7.429e+004			kg	Technosphere	
	Output	Residue	Mineral waste	0.2429			kg	Technosphere	
	Output	Residue	Mining waste	0.07451			kg	Technosphere	
	Output	Residue	Mn	0.0008194			kg	Technosphere	
	Output	Residue	Ni	1.454e-005			kg	Technosphere	
	Output	Residue	Non-magnetic	0.03221			kg	Technosphere	
	Output	Residue	Non-toxic chemicals	0.02208			kg	Technosphere	
	Output	Residue	Oil	0.07444			kg	Technosphere	
	Output	Residue	Oil Emulsion	0.0008305			kg	Technosphere	
	Output	Residue	Olivine	13.24			kg	Technosphere	
	Output	Residue	Other	227.7			kg	Technosphere	
	Output	Residue	Other paper	0.01073			kg	Technosphere	
	Output	Residue	Other rest products	11.26			kg	Technosphere	
	Output	Residue	Oxide scale	32.2			kg	Technosphere	
	Output	Residue	Paper	0.005113			kg	Technosphere	
	Output	Residue	Particles	39.06			kg	Technosphere	
	Output	Residue	Pb	0.0006248			kg	Technosphere	
	Output	Residue	Pit Furnace Slag	55.87			kg	Technosphere	
	Output	Residue	Radioactive	0.02445			kg	Technosphere	
	Output	Residue	Radioactive waste	0.0001927			kg	Ground	
	Output	Residue	Red mud	0.02495			kg	Technosphere	
	Output	Residue	Refractory	0.0002679			kg	Technosphere	
	Output	Residue	Refractory Lining	21.96			kg	Technosphere	
	Output	Residue	Regulated chemicals	8.497			kg	Technosphere	
	Output	Residue	Rocks	0.0001792			kg	Technosphere	
	Output	Residue	Rubber	0.000148			kg	Technosphere	
	Output	Residue	Scrap	0.03664			kg	Technosphere	
	Output	Residue	Skimmings and dross for recycling	0.0002821			kg	Technosphere	
	Output	Residue	Slag	0.3032			kg	Technosphere	
	Output	Residue	Slag	12.08			kg	Technosphere	
	Output	Residue	Slags & ashes	167.6			kg	Technosphere	
	Output	Residue	Slags & ashes (energy production)	7.611			kg	Technosphere	
	Output	Residue	Slags & ashes (waste incineration)	1.892e-006			kg	Technosphere	
	Output	Residue	Sludge	8.876			kg	Technosphere	
	Output	Residue	Solid	81.49			kg	Technosphere	
	Output	Residue	solvent	0.0005006			kg	Technosphere	
	Output	Residue	Steel	0.8125			kg	Technosphere	
	Output	Residue	Steel scrap	160.4			kg	Technosphere	
	Output	Residue	Sulphur	0.0006197			kg	Technosphere	
	Output	Residue	Teeming Channel Bricks	8.575			kg	Technosphere	
	Output	Residue	Tools	3.833			kg	Technosphere	
	Output	Residue	Toxic chemicals	0.0007728			kg	Technosphere	
	Output	Residue	Waste	4.962			kg	Technosphere	
	Output	Residue	Waste Incinerated	0.04537			kg	Technosphere	
	Output	Residue	Waste water	1615			kg	Water	
	Output	Residue	Water	20.03			kg	Water	
	Output	Residue	Wood	22.56			kg	Technosphere	

	Output	Residue	Zn	0.0023			kg	Technosphere

About Inventory	
Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The dataset is applicable to the manufacturing of SKF spherical roller bearing 232/530 at SKFs site in Göteborg, Sweden. This study is a case specific investigation of the production of spherical roller bearings produced at the production site of SKF Sverige AB in Göteborg, Sweden during the years 2000 - 2002
About Data	Most data in the product system has been collected from specific sites and is therefore only valid for these. They can be used as approximations for other systems with care. Some components are produced abroad and data has then been collected from these specific sites. If no data was available from the specific sites, average production data from different databases (mostly CIT Ekologik AB and Spine CPM) has been used for the activities. This is described in detail for each activity available in the SPINE@CPM database. Data has preferably been collected from Environmental Reports and Safety Data Sheets. In some cases production data is monitored continually at the sites. The data from interviews with employees at the respective companies can be considered as expert out spokes. When data have not been available, persons familiar with the processes studied have made qualified estimations. For detailed information see the Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström; Chalmers University of Technology; December 2002.
Notes	

SPINE LCI dataset: Production of Soap from palm oil/palm kernel oil

Administrative	
Finished	Y
Date Completed	92-04-01
Copyright	Carl Hanser Verlag
Availability	Public

Technical System	
Name	Production of Soap from palm oil/palm kernel oil
Functional Unit	1000 kg.
Functional Unit Explanation	All emissions, use of resources and energy consumption is based on 1000 kg of Soap made from palm/palm kernel oils.

Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	BRIEF DESCRIPTION: The following processes are involved in the production of soap from palm oil (PO) and palm kernel oil (PKO): Fresh fruit bunch harvesting: Operation include palm plantations in Malaysia, which is the major exportin country of palm oil/palm kernel oil. Crude palm oil production: The palm oil is produced from fresh fruit buches. The process includes palm extraction mills in Malaysia. Palm oil refining: Palm oil refining takes place in Malaysia. No further details were given on the refining process. Palm kernel production: Palm kernel is produced from fresh fruit bunches. The operation includes palm plantations in Malaysia. Crude palm kernel oil production: The crude palm kernel oil is produced from palm kernel. The process includes palm extraction mills and kernel crushing plants in Malaysia. Palm kernel oil refining: Palm kernel oil refining takes place in Malysia. No further details were given on the process. Fatty acid splitting: The PO and the PKO is split to varying chain length fatty acids. Salt production: The salt is used for caustic soda production. No details were given on the production. Caustic soda production: Caustic soda is used for the final saponification. No details were given on the production of caustic soda. Saponification The process is a continous one, where the fatty acids are neutralized with caustic soda to form soap. Information concerning all the subsystems described above: Transports are included in the system. The fuels for the transports and the fuels for the processes are traced back to the extraction of petrochemical raw materials and/or extraction of bio fuels. The electricity data are based on the electricity profile for each country and the petrochemical and biomass raw materials for electricity production are traced back to the extraction process (same process as for fuel raw materials).

System Boundaries	
Nature Boundary	All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).The detergent formulation, use and final disposal of the surfactants were not covered. All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	The process data used pertain mainly to 1992, being yearly averages where possible. It is recognised that operating processes and conditions are constantly evolving.
Geographical Boundary	This study examined the surfactant production in Europe, notably manufacturing processes conducted in Belgium, France, Germany, Italy, the Netherlands, Spain and the United Kingdom. Some raw materials are produced outside of Europe. Therefore relevant input data from Malaysia, the Philippines and the United States of America have also been incorporated.
Other Boundaries	The detergent formulation, use and final disposal of the surfactants were not covered. The environmental effects associated with the manufacture of capital equipment and with energy and fuel requirements for plant and building conditioning (heat, air etc.) were not included, neither were those associated with personnel requirements. For electricity based on nuclear power and wind power, no emissions and resource exploits have been accounted for.

Allocations	Raw materials, energy and environmental emissions are allocated among co-products on an output weight basis, i.e. on the basis of mass. Co-products in this LCI include those materials that are currently recycled, reused or marketed in some beneficial way.
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study)

Flow Data	
General Activity QMetaData	
Date Conceived	92-04-01
Data Type	
Represents	European average
Method	LCI data from tables 2, 10 and 14 on pages 160-167 in lit. ref.
Literature Reference	Tenside Surfactants Detergents; 32. Jahrgang 2/1995; Carl Hanser Verlag; Munchen
Notes	The raw material data are given in ''kg'' and the energy data are given in ''MJ''. However, it is important to remember that the raw materials themselves have an energy content.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Energy resource. The thermal value of coal is 27 MJ/kg.	Input	Natural resource	Coal	1223			MJ	Ground	
Notes: Energy resource. The thermal value of crude oil is 42 MJ/kg.	Input	Natural resource	Crude oil	7098			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Fruit	1855			kg	Ground	
Notes: Energy resource. The thermal energy of fruit with a high water content is 15 MJ/kg.	Input	Natural resource	Fruit	6555			MJ	Ground	
Notes: Raw material.	Input	Natural resource	NaCl	98			kg	Ground	
Notes: Energy resource. The thermal value of natural gas is 45 MJ/kg.	Input	Natural resource	Natural gas	1413			MJ	Ground	
Represents: Electricity produced by hydro power. Notes: Source of energy.	Input	Refined resource	Hydro power	290			MJ	Technosphere	
Represents: Electricity produced by nuclear power. Notes: Source of energy.	Input	Refined resource	Nuclear	580			MJ	Technosphere	
	Output	Emission	Acid	0.013			kg	Water	
	Output	Emission	Aldehydes	0.062			kg	Air	
	Output	Emission	BOD	1.55			kg	Water	
	Output	Emission	CH4	17.8			kg	Air	
	Output	Emission	Chlorine	0.0033			kg	Air	
	Output	Emission	CO	1.27			kg	Air	
Notes: Non-fossil emissions of CO2.	Output	Emission	CO2	508			kg	Air	
Notes: Fossil emissions of CO2.	Output	Emission	CO2	732			kg	Air	
	Output	Emission	COD	7.76			kg	Water	
	Output	Emission	Cr	0.201			g	Water	
	Output	Emission	Dissolved solids	7.5			kg	Water	
	Output	Emission	Fe	0.0046			kg	Water	
	Output	Emission	Fluorides	0.0032			kg	Water	
	Output	Emission	Fluorine	0.0032			kg	Air	
	Output	Emission	HC	0.0063			kg	Water	
	Output	Emission	HC	3.15			kg	Air	
	Output	Emission	HCl	0.03			kg	Air	
	Output	Emission	HF	0.0037			kg	Air	
	Output	Emission	Hg	0.33			g	Air	
	Output	Emission	Hg	38.2			mg	Water	
	Output	Emission	Metal ion	0.0075			kg	Water	
	Output	Emission	Metals	0.0032			kg	Air	
	Output	Emission	NH3	0.0057			kg	Air	
	Output	Emission	Ni	35.3			mg	Water	
	Output	Emission	NOx	5.88			kg	Air	
	Output	Emission	N-tot	0.075			kg	Water	

	Output	Emission	Odorous sulphurs/thiols	0.12			kg	Air	
	Output	Emission	Oil	0.085			kg	Water	
	Output	Emission	Other chemicals	48.8			mg	Water	
	Output	Emission	Other organics	0.13			kg	Air	
	Output	Emission	Particles	3.59			kg	Air	
	Output	Emission	Pb	16.1			mg	Water	
	Output	Emission	Pb	42.4			mg	Air	
	Output	Emission	Phenol	0.0044			kg	Water	
	Output	Emission	Solid waste	4.1			kg	Ground	
	Output	Emission	SOx	7.36			kg	Air	
	Output	Emission	Sulphides	0.0039			kg	Water	
	Output	Emission	Susp solids	2.37			kg	Water	
	Output	Emission	Zn	0.177			g	Water	
	Output	Product	Soap	1000			kg	Technosphere	

About Inventory

Publication	Tenside Surfactants Detergents; 32. Jahrgang 2/1995; Carl Hanser Verlag; Munchen -- Data documented by: Malin Ericson, Akzo Nobel Surface Chemistry Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Manufacturers and users of sur
General Purpose	-To produce an authoritative and comprehensive Life Cycle Inventory for major surfactant production in Europe through a common approach in order to facilitate objectivity in surfactant assessments on environmental grounds. -To secure the best possible validation of data and broad acceptance of the methodology and conclusions by industry, regulatory authorities, and academia, through assessment of the study by an appropriate expert review panel.
Detailed Purpose	-To establish an industry-wide inventory of the energy and emissions associated with the production of major surfactants in Western Europe under the conditions prevailing in 1992. -To bring together environmental data on the use of the main raw material sources - crude oil, natural gas, mineral, oleochemical, agricultural feedstock - for the processing pathways to the derived major surfactants. -To provide benchmarks for the processing steps of surfactant production against which individual producers can assess their own processes and identify opportunities for improvement. -To publish the results of the study and its conclusions in the open literature for access and reference by interested bodies.
Commissioner	- European LCI Surfactant Study Group (CEFIC/ECOSOL).
Practitioner	- Franklin Associates, Ltd. 4121 W. 83rd St., Suite 108 Prairie Village, KS 66208, USA.
Reviewer	Klöppfer, Prof. Dr. W. - C.A.U. Consultants Frankfurt, Germany
Applicability	It is generally not possible to replace one surfactant type by another without changing other components of a preparation, or altering performance characteristics. Therefore, it is not in general meaningful to compare surfactants on a weight basis. Soap is one of the oldest surfactants having been widely used since ancient times. In practice and certainly in its predominant forms, the fatty acid in soap is rarely unique but comprises a range of alcohol chain lengths stemming from oleochemical feestock (animal and vegetable). Soap continues to be the major surfactant in the world. However, soap use has declined in Western Europe due to the increasing use of petrochemical based surfactants.
About Data	13 industrial companies participated in the project, including major surfactant manufacturers, raw material and intermediate suppliers, as well as surfactant users in Europe, some of whom are both manufacturers and users. Participating companies are BASF, Colgate-Palmolive, Condea, Enichem Augusta, Henkel, Hoechst, Hüls, ICI, Petresa, Procter & Gamble, Shell, Unilever and Wibarco. Process data were obtained directly from each company performing the process. These data were often proprietary. Therefore, technical process data from private corporations were collected from a minimum of three producers for each intermediate and surfactant type. The information is presented in the form of industry averages in order to preserve confidentiality. Fuel-related data for European countries were based on various governmental statistics and industry contacts (aggregated and provided by Dr. I. Bousted, The Open University, UK).

Notes	Data for other surfactants such as Alcohol sulphates (AS), Alcohol ethoxy sulphates (AES), Linear alkylbenzene sulphonates (LAS), Secondary alkane sulphonates (SAS), Alcohol ethoxylates (AE) and Alkyl polyglucosides (APG) were given in the same study.

SPINE LCI dataset: Production of sodium sulphate

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System	
Name	Production of sodium sulphate
Functional Unit	1 kg
Functional Unit Explanation	1 kg sodium sulphate.
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Production of sodium sulphate.

System Boundaries	
Nature Boundary	No such parameters are measured in this study. No emissions for oil combustion is included
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are electricity and fossil fuel consumption, but no emission from the combustion (produciton) is included. The sodium sulphate goes to the technosphere. No transports are included.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1991-01-01
Data Type	Unspecified
Represents	European average
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.

Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	The inputs, (raw-)material, is not known.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: The amount 80 kWh/ton is recalculated to 0,288 MJ/kg in the reference litterature.	Input	Refined resource	Electricity	0.288			MJ	Technosphere	
Notes: Assumed to be oil.	Input	Refined resource	Fossil fuel	0.395			MJ	Technosphere	
	Output	Product	Sodium sulphate	1			kg	Technosphere	

About Inventory

Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden --- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology ---
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and use of glass.
Detailed Purpose	To show the energy consumption for production of sodium sulphate.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	The emission factors for stationary installations of oil combustion can be found under the activity ''Combustion of oil'' in this database.
About Data	The fossil fuel is assumed to be oil. The inputs, (raw-)material, for production of sodium sulphate is not known.
Notes	

SPINE LCI dataset: Production of Solvey soda

Administrative

Finished	Y
Date Completed	1991-01-01
Copyright	
Availability	Public

Technical System

Name	Production of Solvey soda
Functional Unit	1 kg

Functional Unit Explanation	1 kg Solvey soda.
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Production of Solvey soda.

System Boundaries

Nature Boundary	No such parameters are measured in this study. No emission from the combustion (production) of oil is included.
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are electricity and oil consumption Solvey soda goes to the technosphere. No transports are included.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991-01-01
Data Type	Unspecified
Represents	European average
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden which is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	The inputs, (raw-)material, is not known.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: The amount 1671 kWh/ton is recalculated to 6,02 MJ/kg in the reference literature.	Input	Refined resource	Electricity	6.02			MJ	Technosphere	
Method: The amount 106 l/ton soda is recalculated to 4,060 MJ/kg soda in the reference literature.	Input	Refined resource	Oil	4.060			MJ	Technosphere	
	Output	Product	Solvay soda	1			kg	Technosphere	

About Inventory

Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --

Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and use of glass.
Detailed Purpose	To show the energy consumption for production of Solvey soda.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	The emission factors for stationary installations of oil combustion can be found under the activity ''Combustion of oil'' in this database.
About Data	The inputs, (raw-)material, for the production of Solvey soda is not known.
Notes	

SPINE LCI dataset: Production of styrene (APME)

Administrative	
Finished	Y
Date Completed	1999
Copyright	APME
Availability	Public

Technical System	
Name	Production of styrene (APME)
Functional Unit	1 kg of styrene
Functional Unit Explanation	Styrene is a precursor for production of polystyrene, SBR, SB dispersions, ABS resins and unasaturated resins.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Production of styrene includes all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. The production of styrene monomer can be thought of as replacing one of the hydrogen atoms in ethylene by a benzene ring (C6H6). In practice, the production route from crude oil and natural gas is different. Crude oil refining produces a fraction known as naphtha which contains a mixture if low molecular weight, saturated hydrocarbons of various composition. This is converted into a smaller group of unsaturated hydrocarbons by cracking - a process in which the naphtha is heated to a high temperature in the absence of air, maintained for a short time at this high temperature and then very rapidly cooled back to a low temperature when all of the reactions stop and the mix of products is essentially fixed. The resulting mixture is then separated into its constituent components by distillation producing principally ethylene (C2H4), propylene (C3H6), mixed butenes of general formula C4H8 and a number of other compounds which find uses elsewhere in the petrochemical plant either as feedstocks or fuels. The precise mix of products from cracking are determined by a number of factors such as cracker temperature, residence time and the nature of the feedstock and the operation of a cracker can often be adjusted to produce the required mix of products. Natural gas is also converted into ethylene, propylene, butenes and other products by cracking.

	Although benzene is usually present in small quantities in crude oil, its direct extraction is usually uneconomic. However, one by-product of naphtha cracking is a liquid usually referred to as pyrolysis gasoline which is high in unsaturated aliphatic and aromatic hydrocarbons. The benzene fraction in pyrolysis gasoline can be extracted by repeated distillation and it is thought that about half of all benzene used in Europe is produced in this way. Benzene is also produced directly from naphtha by a process known as catalytic reforming. The basic feedstock is converted into a mixture of products of which the principal components are benzene, toluene and xylene (the process is often referred to as th BTX process). Benzene and other aromatics are isolated in the pure state from the output of the reformer by solvent extraction and fractional distillation. The relative proportions of benzene derived from the two sources vary from one operator to another but, in the later calculations, when the precise mix is unknown - as for example, when benzene is purchased on the open market - it is assumed that 50% is derived from each source. Subsystems: 1. Natural gas production 1. Crude oil production 2. Natural gas processing 2. Oil refining, for naphtha 3. Cracking for ethylene 3. Reforming for benzene 4. Reforming for benzene System: 1. Ethylbenzene production 2. Styrene production Styrene polymerisation (with polybutadiene) - gives high impact polystyrene. Styrene polymerisaton - gives crystal or general purpose polystyrene Styrene polymerisation (with pentane) - gives expandable polystyrene In addition to the mentioned sub-processes, the following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and deliver; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been tracked back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 10 plants in 4 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries

Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1990-1994. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Results are based on data supplied by 11 styrene production plants in 6 countries: Belgium, France, Germany, Italy, Netherlands and UK. Their total production was 3,9 tonnes. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production.

	The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.
Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 11 production plants in 6 countries: Belgium, France, Germany, Italy, Netherlands and UK. Their total production was 3,9 million tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.ed to the electricity.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1990-1994
Data Type	Derived, mixed
Represents	European average
Method	European average data. Results are based on data supplied by 11 production plants in 6 countries: Belgium, France, Germany, Italy, Netherlands and UK. Their total production was 3,9 million tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-

	files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports/htm/alphabetical.htm
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Air	73407.98798			mg	Air	Europe
	Input	Natural resource	Barytes	0.111682914			mg	Ground	Europe
	Input	Natural resource	Bauxite	794.6879937			mg	Ground	Europe
	Input	Natural resource	Bentonite	225.7311519			mg	Ground	Europe
	Input	Natural resource	Biomass	724.5037065			mg	Ground	Europe
	Input	Natural resource	Calcite	2090.434361			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	22.50900584			mg	Ground	Europe
	Input	Natural resource	Chalk	2.49E-22			mg	Ground	Europe
	Input	Natural resource	Clay	15.86976153			mg	Ground	Europe
	Input	Natural resource	Cr	2.29E-05			mg	Ground	Europe
	Input	Natural resource	Crude oil	662531.5102			mg	Ground	Europe
	Input	Natural resource	Dolomite	10.63034515			mg	Ground	Europe
	Input	Natural resource	Fe	942.9819802			mg	Ground	Europe
	Input	Natural resource	Feldspar	3.71E-28			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	0.784524642			mg	Ground	Europe
	Input	Natural resource	Fluorite	6.757155311			mg	Ground	Europe
	Input	Natural resource	Granite	4.15E-03			mg	Ground	Europe
	Input	Natural resource	Gravel	3.186819925			mg	Ground	Europe
	Input	Natural resource	Hard coal	57305.39963			mg	Ground	Europe
	Input	Natural resource	Hard coal	5823.536481			mg	Ground	Europe
	Input	Natural resource	Hydro energy	7.23E-02			MJ	Ground	Europe
	Input	Natural resource	Metallurgical coal	348.7961209			mg	Ground	Europe
	Input	Natural resource	Mg				mg	Ground	Europe
	Input	Natural resource	Natural gas	1102344.088			mg	Ground	Europe
	Input	Natural resource	Ni	6.00E-06			mg	Ground	Europe
	Input	Natural resource	Nitrogen	27946.96237			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	0.782645583			MJ	Ground	Europe

	Input	Natural resource	Olivine	8.103293644			mg	Ground	Europe
	Input	Natural resource	Oxygen	27.01871259			mg	Ground	Europe
	Input	Natural resource	Pb	1.028298114			mg	Ground	Europe
	Input	Natural resource	Peat	3.460671738			mg	Ground	Europe
	Input	Natural resource	Phosphate	0.11520695			mg	Ground	Europe
	Input	Natural resource	Potassium chloride	1.405072259			mg	Ground	Europe
	Input	Natural resource	Rutile	3.58E-22			mg	Ground	Europe
	Input	Natural resource	Sand	109.4779569			mg	Ground	Europe
	Input	Natural resource	Shale oils	63.72299552			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	1751.443828			mg	Ground	Europe
	Input	Natural resource	Sulphur	87.21238653			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	30.27736817			mg	Ground	Europe
	Input	Natural resource	Talc				mg	Ground	Europe
	Input	Natural resource	Water	157839953.3			mg	Water	Europe
	Input	Natural resource	Wood	1.094403594			mg	Ground	Europe
	Input	Natural resource	Zn	3.87E-02			mg	Ground	Europe
	Output	By-product	Recovered energy	4.337649136			MJ	Technosphere	Europe
	Output	By-product	To incinerator	746.6958727			mg	Technosphere	Europe
	Output	By-product	To recycling	92.49835194			mg	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane	4.37E-08			mg	Air	Europe
	Output	Emission	1,2-Dichloroethane	8.17E-11			mg	Water	Europe
	Output	Emission	Acid as H+	39.2017314			mg	Water	Europe
	Output	Emission	Al	102.8754214			mg	Water	Europe
	Output	Emission	Aldehydes	1.03E-03			mg	Air	Europe
	Output	Emission	As	3.25E-04			mg	Water	Europe
	Output	Emission	BOD5	20.73389934			mg	Water	Europe
	Output	Emission	Ca2+	0.576534137			mg	Water	Europe
	Output	Emission	CH4	7871.570539			mg	Air	Europe
	Output	Emission	Chloroorganics	0.355138375			mg	Air	Europe
	Output	Emission	Chloroorganics	1.52E-04			mg	Water	Europe
	Output	Emission	Cl-	3478.727519			mg	Water	Europe
	Output	Emission	Cl2	1.40E-03			mg	Water	Europe
	Output	Emission	Cl2	4.27E-02			mg	Air	Europe
	Output	Emission	CN-	1.27E-02			mg	Water	Europe
	Output	Emission	CO	1554.829222			mg	Air	Europe
	Output	Emission	CO2	2411713.374			mg	Air	Undefined
	Output	Emission	CO32-	199.4128431			mg	Water	Europe
	Output	Emission	COD	307.3735067			mg	Water	Europe
	Output	Emission	CrO3	2.75E-05			mg	Water	Europe
	Output	Emission	CS2	3.00E-04			mg	Air	Europe
	Output	Emission	Cu	0.130209296			mg	Water	Europe
	Output	Emission	Dissolved organics	29.95783046			mg	Water	Europe
	Output	Emission	Dissolved solids	89.07757867			mg	Water	Europe
	Output	Emission	F-	0.187461881			mg	Water	Europe
	Output	Emission	F2	5.16E-03			mg	Air	Europe
	Output	Emission	Fe	9.12E-02			mg	Water	Europe
	Output	Emission	H2	45.93337149			mg	Air	Europe
	Output	Emission	H2S	0.3232148			mg	Air	Europe
	Output	Emission	H2SO4	4.05E-07			mg	Air	Europe
	Output	Emission	Halogenated hydrocarbons (chlorofluoroca	0.612631536			mg	Air	Europe
	Output	Emission	HCl	16.38134126			mg	Air	Europe
	Output	Emission	HCN	1.22E-27			mg	Air	Europe

	Output	Emission	HF	0.702180456			mg	Air	Europe
	Output	Emission	Hg	3.14E-03			mg	Water	Europe
	Output	Emission	Hg	5.53E-02			mg	Air	Europe
	Output	Emission	K+	4.28E-02			mg	Water	Europe
	Output	Emission	Metals	2.84736418			mg	Air	Europe
	Output	Emission	Metals	452.4741857			mg	Water	Europe
	Output	Emission	Mg	1.76E-02			mg	Water	Europe
	Output	Emission	N total	6.842282818			mg	Water	Europe
	Output	Emission	Na	704.8114567			mg	Water	Europe
	Output	Emission	NH3	5.14E-02			mg	Air	Europe
	Output	Emission	NH4+	7.842228921			mg	Water	Europe
	Output	Emission	Ni	0.126705527			mg	Water	Europe
	Output	Emission	NO	9203.73628			mg	Air	Europe
	Output	Emission	NO2	8.57E-02			mg	Air	Europe
	Output	Emission	NO3-	2.607799568			mg	Water	Europe
	Output	Emission	Oil	52.99387765			mg	Water	Europe
	Output	Emission	P2O5	0.495103326			mg	Water	Europe
	Output	Emission	PAH	2.00E-28			mg	Air	Europe
	Output	Emission	Particles	1110.455652			mg	Air	Europe
	Output	Emission	Pb	2.82E-04			mg	Air	Europe
	Output	Emission	Pb	9.22E-04			mg	Water	Europe
	Output	Emission	Phenol	3.409808223			mg	Water	Europe
	Output	Emission	S2-	0.505873267			mg	Water	Europe
	Output	Emission	SO42-	273.4301443			mg	Water	Europe
	Output	Emission	SOx	6776.450273			mg	Air	Europe
	Output	Emission	Suspended solids	319.2664146			mg	Water	Europe
	Output	Emission	Thiols	8.46E-02			mg	Air	Europe
	Output	Emission	Vinyl chloride	2.72E-08			mg	Air	Europe
	Output	Emission	Vinyl chloride	4.66E-25			mg	Water	Europe
	Output	Emission	VOC	1.350507587			mg	Water	Europe
	Output	Emission	VOC	141.7487229			mg	Air	Europe
	Output	Emission	VOC	2.999129442			mg	Air	Europe
	Output	Emission	VOC	2364.845845			mg	Air	Europe
	Output	Emission	VOC	76.31804552			mg	Water	Europe
	Output	Emission	Zn	7.39E-03			mg	Water	Europe
	Output	Product	Styrene	1			kg	Technosphere	Europe
	Output	Residue	Construction	18.10222936			mg	Ground	Europe
	Output	Residue	Industrial	1101.303212			mg	Ground	Europe
	Output	Residue	Inert chemical	1147.342888			mg	Ground	Europe
	Output	Residue	Metals	5.99766502			mg	Ground	Europe
	Output	Residue	Mineral	14537.08979			mg	Ground	Europe
	Output	Residue	Paper & board	1.27E-21			mg	Ground	Europe
	Output	Residue	Plastics	1.759498891			mg	Ground	Europe
	Output	Residue	Regulated chemical	460.4180034			mg	Ground	Europe
	Output	Residue	Slags & ashes	1944.128119			mg	Ground	Europe
	Output	Residue	Unspecified	13.48974518			mg	Ground	Europe
	Output	Residue	Wood waste	1.09E-02			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for styrene. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. -- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 --
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.

Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .
Reviewer	-
Applicability	European average data. Results are based on data supplied by 11 styrene production plants in 6 countries: Belgium, France, Germany, Italy, Netherlands and UK. Their total production was 3,9 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for styrene production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of styrene in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Note that emissions <0,5 mg (0,25 mg in data table) may be far below 0,5 mg in some cases. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity.

	According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. CO2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

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SPINE LCI dataset: Production of sulphuric acid by roasting of pyrite

Administrative	
Finished	Y
Date Completed	99-01-25
Copyright	
Availability	Public

Technical System	
Name	Production of sulphuric acid by roasting of pyrite
Functional Unit	1 kg of sulphuric acid (100 %)

Functional Unit Explanation	
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	The dataset is intended to represent production of sulphuric acid by roasting of pyrite. Data are taken from reports on fertiliser production, i.e. no specific site has been studied. The text below gives generic information of production of sulphuric acid, the data do not necessarily represent these techniques. Further information about interpretations of what the data represent is given in the flow data window. Sulphuric acid results from the production of sulphur dioxide, its conversion into sulphur trioxide and finally, absorption of sulphur trioxide by water, giving sulphuric acid. These reactions are exothermic to various extent, except for the production of sulphur dioxide from metal sulphate roasting or regeneration of sulphuric acid, and, in the case of brimstone as raw material, 1.1 to 1.2 t steam is produced per tonne sulphuric acid. This steam can, for example, be used to produce electricity and to concentrate phosphoric acid in adjacent plants. Since there are many different sulphur raw materials, there are several ways of producing sulphur dioxide as well (UNEP, 1996). Thereafter, the production route is less dependent on the original sulphur source, even though there are several processes for the conversion and the absorption stage (BAT N° 3, 1995). Approximately 0.33 t brimstone, 0.76 t pyrite (48 % S) or 1.2t zinc ore is typical raw material input for the production of 1t sulphuric acid (100%) (UNEP, 1996). Roasting of Pyrite Pyrite, or iron sulphide, is roasted in various types of furnaces, e.g. multiple-hearth furnace, rotary kiln and fluid bed roaster, producing a gas with a somewhat lower sulphur dioxide content than the combustion gases from burning elemental sulphur. This gas is then diluted to 8-10 % sulphur dioxide and treated in a high efficiency dust collector, e.g. electro-static dust collector, before conversion (BAT N° 3, 1995). The sulphur oxides is the main product and the iron oxides is the by-product (Patyk, 1996). Production of Sulphur Trioxide A catalyst, often containing alkali and vanadium oxides, is involved in the conversion of sulphur dioxide into sulphur trioxide (BAT N° 3, 1995). In case of roasting of metallic sulphides the sulphur dioxide containing combustion gases are first cleaned and dried, but if the sulphur dioxide is produced via sulphur burning, the air is dried before combustion (UNEP, 1996). If the oxygen concentration in the process gas is low after the combustion or roasting step, additional air or oxygen must be added prior to or during catalytic oxidation to ensure that there is an excess over stoichiometric needs for conversion of sulphur dioxide to sulphur trioxide. This reaction is highly exothermic and equilibrium becomes increasingly unfavourable for sulphur trioxide formation as temperature increases above 410-430°C. Unfortunately, this is the minimum temperature level required for typical commercial catalysts to function. As a result, plant catalytic converters are typically designed as multistage adiabatic units with gas cooling between each stage (Kirk-Othmer, vol. A 23, 1997). Production of Sulphuric Acid Single Contact Process In single contact plants, sulphuric trioxide is absorbed at the end of the process. Nowadays, this process is only used in new plants when the sulphur dioxide content of the combustion gas is low and widely varying (UNEP, 1996). After the conversion step the sulphur trioxide is absorbed in sulphuric acid in absorbers where it is converted to sulphuric acid by the water in the sulphuric acid. The absorbing acid is kept at the constant desired concentration of approximately 99 % by the addition of water or dilute sulphuric acid. If the concentration of sulphur dioxide in the combustion gas is between 6 and 10 %, the conversion efficiency is about 98 %. It is difficult to obtain more than 98.0 % in existing plants. The conversion ratio is somewhat lower if the concentration of sulphur dioxide in the combustion gas is less then 6 % (BAT N° 3, 1995). Double Contact Process In the early 1970s, air pollution problems led to the adoption of the double contact process or double absorption process (Kirk-Othmer, vol. 23). In this process there is a primary converter followed by an intermediate absorber, a secondary converter and a final absorber. The absorption of sulphur trioxide in the intermediate absorber shifts the equilibrium towards the formation of sulphur trioxide in the residual gas, resulting in an overall conversion efficiency of at least 99.6 % in case of sulphur burning. Feed gases containing 9-12 % sulphur dioxide is generally used for this process (BAT N° 3, 1995). Pressure Contact Process The oxidation of sulphur dioxide is favoured by high pressure and therefore, pressure contact processes has been developed. In these processes the sulphur dioxide conversion and the sulphur trioxide absorption are both carried out at high pressure. Even higher conversion ratio, 99.80-99.85 % is reported for this type of process. On the other hand, the temperature in the sulphur furnace is higher than the double contact process, which

increases the nitrogen oxide formation. The process also consumes more power and produces less steam than the conventional double-contact process. The process is not new but so far, it has only been employed in one industrial double-absorption plant in France (BAT N° 3, 1995).

Wet Contact Process
Contrarily to the conventional contact processes in which dry mixtures of sulphur dioxide and air are treated, wet gas is used in the wet gas process. This process has been employed to treat off-gases containing at least 10% hydrogen sulphide from cookeries, mineral oil refineries, fuel gasification or low-temperature carbonisation plants, natural gas cleaning installations, carbon bisulphide production plants and synthetic fibre plants. The hydrogen sulphide in the treated off-gas is first burnt to sulphur dioxide and water (steam) and the sulphur dioxide is then converted to sulphur trioxide which together with the formed steam yields sulphuric acid. The concentration of the produced acid is between 78 and 93 %. Gases with a lower hydrogen sulphide content than 10% have to be burnt by additional heating, e.g. fuel gas, oil or sulphur (UNEP, 1996). The conversion efficiency, regarding sulphur dioxide, of the Wet Contact Process is normally about 95-98 % (BAT N° 3, 1995).

Other Processes
The Modified Lead Chamber process is able to treat gases with a low content of sulphur dioxide, 0.5-8 %, but also gases containing a mixture of sulphur dioxide and nitrogen oxides. The nitrogen oxides are used to promote acid production directly from sulphur dioxide. The process is potentially useful for cleaning the off-gases from power plants and ore roasting plants. The conversion efficiency is almost 100% for sulphur dioxide contents between 0.5 and 8 % but emissions of nitrogen oxides occur to relatively high extent (BAT N° 3, 1995).

There is also a process in which hydrogen peroxide is used to convert sulphur dioxide to sulphur trioxide. The efficiency is higher than 99 % and no waste is generated but the cost for hydrogen peroxide makes this process uneconomic for sulphuric acid production, unless emissions lower than those of the double contact process are required (BAT N° 3, 1995).

The most recent and rather radical development in sulphuric acid technology has taken place in Russia. A process in which the gas flow is periodically reversed over a single-bed converter has been reported. It is claimed that this process permits the treatment of gases of low and variable concentrations of sulphur dioxide, without the need for much of the expensive heat exchange equipment associated with other processes (BAT N° 3, 1995).

References:
BAT N° 3 (1995). Production of Sulphuric Acid, Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry. EFMA - European Fertilizer Manufacturers' Association, Ave. E van Nieuwenhuyse 4, B-1160 Brussels, Belgium.

Kirk-Othmer (1997). Encyclopedia of Chemical Technology, Volume 23, p.258-278.

UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France.

System Boundaries

Nature Boundary	The system includes roasting of sulphide, i.e environmental load from production of energy and extraction of sulphide is not included.
Time Boundary	The literature from which data are taken from are published in 1996.
Geographical Boundary	Europe.
Other Boundaries	
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	As no data for production of sulphuric acid by roasting of pyrite was found, energy production was equalled to the steam generated for roasting of pyrite and the emissions were equalled to average values given by UNEP. The dataset is therefore not entirely representative for production of sulphuric acid.
Method	No specific data for production of sulphuric acid by roasting of pyrite was found. The energy production has therefore been equalled to the generation of steam from roasting of sulphide. Data for emissions of SO2 and SO3 are average values from sulphuric acid plants given by UNEP (1996).

Literature Reference	Patyk A (1996). International Conference on Application of Life Cycle Assessment in Agriculture, Food and Non-Food Agro Industry and Forestry: Achievements and Prospects. IFEU-Institut für Energie- und Umweltforschung Heidelberg; Wilkensstrasse 3, D-69120 Heidelberg, Germany. UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France.
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: This figure correlates to roasting of sulphide given by Patyk (1996) and is therfore not entirely representative for the whole production of sulphuric acid.	Input	Refined resource	Steam	-0.98			MJ	Technosphere	Europe
Notes: Sulphur in pyrite.	Input	Refined resource	Sulphur	0.327			kg	Technosphere	Europe
Method: This figure is an average between emission from a single contact plant (10-12 g SO2/kg H2SO4) and emission from a new double contact plant (2-3 g SO2/kg H2SO4). An assumed value by the practitioners.	Output	Emission	SO2	5			g	Air	Europe
Method: This figure is an average between emission from an existing plant (0,6 g SO3/kg H2SO4) and emission from a new double contact plant (0,15 g SO3/kg H2SO4) given by UNEP (1996). An assumed value by the practitioners.	Output	Emission	SO3	0.3			g	Air	Europe
	Output	Product	H2SO4	1			kg	Technosphere	Europe

About Inventory

Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources for the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare production of different fertilisers to each other but to generate a thorough inventory of emissions and use of resources due to the production of fertilisers used in Sweden. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems. Production of sulphuric acid is one step in the line of production of fertilisers containing phosphorus produced in Sweden.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	Applicable for roasting of sulphide in Europe. The data are intended to be used as input information for the production of phosphoric acic that is used in fertiliser production at Hydro Agri AB in Köping, Sweden. The phosphoric acid is imported from Kemira Chemicals in Finland who produces their sulphuric acid by roasting of pyrite. The sulphuric acid is then used to produce phosphoric acid. As no information of production of this sulphuric acid by roasting of pyrite was found, it was

	assumed that roasting of sulphide is equivalent concerning generation of steam. The dataset is included in aggregated datasets for production of fertilisers at Hydro Agri AB in Köping.
About Data	The only emissions taken into account are emissions of SO2 and SO3 due to lack of information. All data are taken from literature, no specific site has been studied.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of titanium dioxid

Administrative	
Finished	Y
Date Completed	1993
Copyright	
Availability	

Technical System	
Name	Production of titanium dioxid
Functional Unit	1 kg
Functional Unit Explanation	1kg titanium dioxide.
Process Type	Cradle to gate
Site	Forbo plant at Krommenie Amsterdam
Sector	Materials and components
Owner	Forbo plant at Krommenie Amsterdam
Technical system description	Production of titanium dioxide, by the chloride process. The titanium dioxide is extracted in the Netherlands and Belgium.

System Boundaries	
Nature Boundary	No emissions for the combustion of coal is included
Time Boundary	
Geographical Boundary	
Other Boundaries	Energy consumption and waste are accounted for in the study.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1993
Data Type	Unspecified
Represents	As no data for production of sulphuric acid by roasting of pyrite was found, energy production was equalled to the steam generated for roasting of pyrite and the emissions were equalled to average values given by UNEP. The dataset is therefore not entirely representative for production of sulphuric acid.

Method	The data are based on information from Potting J and Blok K. De milieugerichte levensykluanalyse van vier typen vioerbedekking. TThe environmental life-cycle assessment of four types of floor covering), P-UB-93-4, Coordination point science shops, Utrecht, 1993
Literature Reference	Potting J and Blok K. De milieugerichte levensykluanalyse van vier typen vioerbedekking. TThe environmental life-cycle assessment of four types of floor covering), P-UB-93-4, Coordination point science shops, Utrecht, 1993
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Coal	23			MJ	Technosphere	
	Input	Refined resource	Electricity	47			MJ	Technosphere	
	Output	Product	Titanium dioxide	1			kg	Technosphere	
	Output	Residue	Hazardous waste	2.3			kg	Other	

About Inventory

Publication	Potting J and Blok K. De milieugerichte levensykluanalyse van vier typen vioerbedekking. TThe environmental life-cycle assessment of four types of floor covering), P-UB-93-4, Coordination point science shops, Utrecht, 1993 -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Detailed Purpose	
Commissioner	
Practitioner	Jönsson Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden.
Reviewer	
Applicability	One must not forget that no emission factors for the combustion of coal is acounted for in the data set.
About Data	
Notes	

SPINE LCI dataset: Production of toluene diisocyanate (APME)

Administrative

Finished	Y
Date Completed	1999
Copyright	APME

Availability	Public

Technical System	
Name	Production of toluene diisocyanate (APME)
Functional Unit	1 kg of TDI
Functional Unit Explanation	TDI- toluene diisocyanate- is used as a precursor in the production of polyurethane.
Process Type	Cradle to gate
Site	Europe
Sector	Materials and components
Owner	Europe
Technical system description	The information given below comprises all available information in the datasheet from APME, from which this data set is acquired. Production of toluene diisocyanate include all major operations from extraction of crude oil and gas to catalytic reforming of naphtha, solvent extraction and fractional distillation. TDI, toluene diisocyanate, is one of the precursors used in the production of polyurethane. The input to the process is crude oil, natural gas, sulphur, coke/natural gas and sodium chloride. There are several intermediates. Ammonia is used for nitric acid production. For further information see literature ref. The following major processes are included: Crude oil extraction and delivery; oil refining for naphtha (fractional distillation); natural gas extraction, processing and deliver; coal mining and delivery. Also electricity production and production of other raw materials have been included on a cradle to gate basis, i.e. all materials and energies have been tracked back to the extraction of raw materials from the earth. Operating conditions: As the data are based on information from 10 plants in 4 different European countries, the operating conditions differ. For the electricity taken in from the public supply, the calculations have taken account of the country specific electricity production efficiency. For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded.

System Boundaries	
Nature Boundary	''The data presented in the result tables are simply a listing of the data for which information is available''. Especially for air and water emissions, the magnitude of many of the parameters often depends on the degree of monitoring of the parameter, since a company which does not monitor the parameter, may have been estimated it instead. The categories used to identify the different emissions or groups of emissions are empirical and reflect the ability of the many plants to identify specific emissions. For instance, methane, aromatic hydrocarbons and polycyclic hydrocarbons have been identified as separate groups, while the more general name hydrocarbons has been reserved for the remainder. However, some companies may not have reported all of the emissions separately. Therefore, the category metals, for example, may include some metals which were specifically identified by other companies and are included under the specific names elsewhere in the tables. Double-counting has been avoided. However, some of the emissions included separately may have contributed to the BOD and COD values. Generally, the emissions to air and water recorded are those remaining after any on-site air or water treatment.
Time Boundary	Data refer to the year 1995-1996. Data for upstream production of fuels and raw materials are probably from the same time, or somewhat older.
Geographical Boundary	European average data. Data were supplied from 3 toluene diicocyanate producers in France, Germany, Italy. For the APME Eco-profiles in general, the coverage of European production varies from 60 to 100% depending upon the product, although this may not be true for some of the intermediates (including toluene). For some intermediates, with the exception of chlorine, sodium hydroxide and electrolytic hydrogen, the average data might not be truly representative of the European average for their production. The values of some of the parameters reflect the country in which the plants are located. For example, plants in countries where much of the electricity is generated from coal, tend to exhibit higher emissions of sulphur oxides than plants in other countries.

Other Boundaries	The following excluded subsystems are explicitly mentioned in the Methodology report: - External incineration of waste and external recycling. Other external waste treatment is, most likely, also excluded, as concluded by the way solid waste is classified. (On-site waste incineration, on the other hand, is included). - Energy consumption and emissions caused by operating personnel: consumption of food and car transports to work. Both were considered to be small compared to the totals. - Capital equipment and buildings, with two exceptions: road transport and oil well operation. In these two cases, construction and maintenance have been included. In most cases, the lifetime of the plants is sufficiently long to allow exclusion of capital equipment and buildings, which typically contribute <0,01% to the totals. No cut-off criteria for exclusion of minor inputs and outputs are stated. However, in the Metholodogy report, a general recommendation is given that it is important to demonstrate that the contribution of an ancillary material to the overall system is negligible, rather than simply assuming it to be negligible because of its small mass. European average data. Results are based on data supplied by 3 production plants in 6 countries: France, Germany and Italy. Their total production was 372,000 tonnes.
Allocations	In the Methodology report and the different ''Eco-profiles...'' reports, the following general co-product allocations are mentioned: - Extraction of crude oil and natural gas: For the North Sea oil rigs, the flare losses and the own-use data have been spread over all of the saleable products on the basis of their calorific values. - Refineries: Inputs and outputs have been partitioned over all usable or saleable refinery products on a simple mass basis. - Crackers: Most likely, this also applies to the products from the crackers: ethylene, propylene, butenes etc. - Chlorine plant (electrolysis of sodium chloride): Stoichiometric allocation of sodium chloride and some other inputs and outputs has been applied to the three products: chlorine, sodium hydroxide and hydrogen. Care was taken to attribute inputs or outputs only to the products which derive benefit from these inputs or outputs. E.g. sulphuric acid is used as a drying agent for chlorine, therefore, the sulphuric acid input should be attributed to chlorine only. Electricity was partitioned on all products on a simple mass basis. - Sulphuric acid: 98% sulphuric acid is widely used as a drying agent. Often, the dilute acid leaving the system can be used as a reagent in other reactions. However, the dilute acid cannot simply be subtracted from the input acid. The energy needed to produce concentrated acid by removing water is attributed to the process. - Hydrochloric acid by-product: In many reactions, chlorine is used as an oxidation or chlorination agent, which inevitably results in the formation of HCl as a by-product. Only the inputs and outputs associated with the production of the stoichiometric amounts of chlorine and hydrogen incorporated into the HCl have been assigned to the HCl. - On-site steam and electricity: A primary energy equivalent corresponding to the steam energy, assuming 80% efficiency, was subtracted from the total energy input. The remainder was assigned to the electricity. These allocations are general for data from APME, and only applicable for datasets where the above mentioned processes are included.
Systems Expansions	Not applied.

Flow Data

General Activity QMetaData

Date Conceived	1995-1996
Data Type	Derived, mixed
Represents	As no data for production of sulphuric acid by roasting of pyrite was found, energy production was equalled to the steam generated for roasting of pyrite and the emissions were equalled to average values given by UNEP. The dataset is therefore not entirely representative for production of sulphuric acid.
Method	European average data. Results are based on data supplied by 3 production plants in 6 countries: France, Germany and Italy. Their total production was 372,000 tonnes. Data were averaged over all plants and weighted by the production (mass) from each plant. Vertical averaging has been applied wherever there have been sufficient data from upstram raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes, before calculating the CO2 emission. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. Data from APMEs website www.lca.apme.org have been downloaded as exe-files. The files are opened and imported into Microsoft Excel. Further, the data from MS Excel is exported to a MS Access database. Data were supplied by the three major producers in Europe, producing

	annually, and are thought to be representative of the current total production volume in Europe.
Literature Reference	APME, Association of Plastics Manufacturers in Europe, website: http://lca.apme.org/reports /htm/alphabetical.htm
Notes	For raw materials, inputs as listed from APME, have been recorded in this data set. For ''Fuels & Feedstocks'', all fueltypes have been included. In addition, ''Total Energy'' for ''Hydro'', ''Nuclear'' and ''Recovered Energy'' fueltypes from ''Primary Fuels & Feedstocks'' have been included. ''Recovered Energy'' has been recorded in this data set as an outflow with positiv sign. For ''Water Use'' the total amount has been recorded. See Notes in Inventory for a list of how the nomenclature for substances used by APME have been translated into the nomenclature used by CPM (CPM 2000:2) The Nomenclature for FlowTypes has in some cases been changed: Old name: Resources New name: Natural resource Old name: Waste New names: Residue Old name: Co-product New name: By-product Although the dataset contains a large number of decimals, which usually implies that there is a great accuracy in the data, we are somewhat questioning about this accuracy.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Air	258144.9646			mg	Air	Europe
	Input	Natural resource	Barytes	88.07177795			mg	Ground	Europe
	Input	Natural resource	Bauxite	577.8652951			mg	Ground	Europe
	Input	Natural resource	Bentonite	118.9293117			mg	Ground	Europe
	Input	Natural resource	Biomass	6404.32177			mg	Ground	Europe
	Input	Natural resource	Calcium sulphate	11.84319574			mg	Ground	Europe
	Input	Natural resource	Chalk	1.25E-22			mg	Ground	Europe
	Input	Natural resource	Clay	7.858399109			mg	Ground	Europe
	Input	Natural resource	Cr	8.61E-06			mg	Ground	Europe
	Input	Natural resource	Crude oil	547054.3016			mg	Ground	Europe
	Input	Natural resource	Dolomite	9.942607936			mg	Ground	Europe
	Input	Natural resource	Fe	837.2871389			mg	Ground	Europe
	Input	Natural resource	Feldspar	3.112503349			mg	Ground	Europe
	Input	Natural resource	Ferromanganese	0.608865444			mg	Ground	Europe
	Input	Natural resource	Fluorite	7.640365618			mg	Ground	Europe
	Input	Natural resource	Granite	4.97E-02			mg	Ground	Europe
	Input	Natural resource	Gravel	2.472304327			mg	Ground	Europe
	Input	Natural resource	Hard coal	333665.3201			mg	Ground	Europe
	Input	Natural resource	Hydro energy	0.788739335			MJ	Ground	Europe
	Input	Natural resource	Lignite	293282.7647			mg	Ground	Europe
	Input	Natural resource	Limestone	127803.8346			mg	Ground	Europe
	Input	Natural resource	Metallurgical coal	21329.4975			mg	Ground	Europe
	Input	Natural resource	Mg				mg	Ground	Europe
	Input	Natural resource	Natural gas	1211762.104			mg	Ground	Europe
	Input	Natural resource	Ni	5.33E-02			mg	Ground	Europe
	Input	Natural resource	Nitrogen	137132.0647			mg	Ground	Europe
	Input	Natural resource	Nuclear energy	8.451286569			MJ	Ground	Europe

	Input	Natural resource	Olivine	7.435657474			mg	Ground	Europe
	Input	Natural resource	Oxygen	34599.37645			mg	Ground	Europe
	Input	Natural resource	Pb	3.309476628			mg	Ground	Europe
	Input	Natural resource	Peat	179.6028602			mg	Ground	Europe
	Input	Natural resource	Phosphate	1.384037979			mg	Ground	Europe
	Input	Natural resource	Potassium chloide	6266.267629			mg	Ground	Europe
	Input	Natural resource	Rutile	1.80E-22			mg	Ground	Europe
	Input	Natural resource	Sand	518.6797457			mg	Ground	Europe
	Input	Natural resource	Shale oils	33.52808715			mg	Ground	Europe
	Input	Natural resource	Sodium chloride	307145.9671			mg	Ground	Europe
	Input	Natural resource	Sulphur	9260.13281			mg	Ground	Europe
	Input	Natural resource	Sulphur (bonded)	4626.19354			mg	Ground	Europe
	Input	Natural resource	Talc				mg	Ground	Europe
	Input	Natural resource	Water	377622661.4			mg	Water	Europe
	Input	Natural resource	Wood	393.2797355			mg	Ground	Europe
	Input	Natural resource	Zn	8.12E-02			mg	Ground	Europe
	Output	By-product	Recovered energy	3.120803331			MJ	Technosphere	Europe
	Output	By-product	To incinerator	16157.53286			mg	Technosphere	Europe
	Output	By-product	To recycling	24.55403804			mg	Technosphere	Europe
	Output	Emission	1,2-Dichloroethane				mg	Water	Europe
	Output	Emission	1,2-Dichloroethane	1.12E-06			mg	Air	Europe
	Output	Emission	Acid as H+	39.8968166			mg	Water	Europe
	Output	Emission	Al	29.84919501			mg	Water	Europe
	Output	Emission	Aldehydes	1.24E-02			mg	Air	Europe
	Output	Emission	As	9.41E-05			mg	Water	Europe
	Output	Emission	BOD5	14.95128507			mg	Water	Europe
	Output	Emission	Ca2+	17802.12066			mg	Water	Europe
	Output	Emission	CH4	22553.14962			mg	Air	Europe
	Output	Emission	Chloroorganics	1.362807318			mg	Air	Europe
	Output	Emission	Chloroorganics	2.667135887			mg	Water	Europe
	Output	Emission	Cl-	61878.00891			mg	Water	Europe
	Output	Emission	Cl2	0.366629667			mg	Air	Europe
	Output	Emission	Cl2	6.843822204			mg	Water	Europe
	Output	Emission	CN-	1.096089667			mg	Water	Europe
	Output	Emission	CO	3428.192457			mg	Air	Europe
	Output	Emission	CO2	4977553.511			mg	Air	Europe
	Output	Emission	CO32-	126.9246747			mg	Water	Europe
	Output	Emission	COD	1177.312491			mg	Water	Europe
	Output	Emission	CrO3	1.04E-05			mg	Water	Europe
	Output	Emission	CS2	8.26E-05			mg	Air	Europe
	Output	Emission	Cu	0.678553819			mg	Water	Europe
	Output	Emission	Dissolved organics	12.77823687			mg	Water	Europe
	Output	Emission	Dissolved solids	4012.40802			mg	Water	Europe
	Output	Emission	F-	0.162860927			mg	Water	Europe
	Output	Emission	F2	4.49E-03			mg	Air	Europe
	Output	Emission	Fe	0.736617994			mg	Water	Europe
	Output	Emission	H2	1302.442044			mg	Air	Europe
	Output	Emission	H2S	3.74E-02			mg	Air	Europe
	Output	Emission	H2SO4	1.34E-05			mg	Air	Europe
	Output	Emission	Halogenated hydrocarbons (chlorofluoroca	2.761663843			mg	Air	Europe
	Output	Emission	HCl	153.5404177			mg	Air	Europe
	Output	Emission	HCN	1.09301818			mg	Air	Europe

	Output	Emission	HF	5.377433868			mg	Air	Europe
	Output	Emission	Hg	0.232887748			mg	Air	Europe
	Output	Emission	Hg	1.12E-02			mg	Water	Europe
	Output	Emission	K+	178.6484571			mg	Water	Europe
	Output	Emission	Metals	315.2661087			mg	Water	Europe
	Output	Emission	Metals	7.069124475			mg	Air	Europe
	Output	Emission	Mg	0.627011467			mg	Water	Europe
	Output	Emission	N total	1010.878133			mg	Water	Europe
	Output	Emission	N2O	0.181890029			mg	Air	Europe
	Output	Emission	Na	21857.72511			mg	Water	Europe
	Output	Emission	NH3	108.0552361			mg	Air	Europe
	Output	Emission	NH4+	839.4854884			mg	Water	Europe
	Output	Emission	Ni	0.534233479			mg	Water	Europe
	Output	Emission	NO3-	7073.003344			mg	Water	Europe
	Output	Emission	NOx	21124.34949			mg	Air	Europe
	Output	Emission	Oil	23.14482248			mg	Water	Europe
	Output	Emission	P2O5	1.130604823			mg	Water	Europe
	Output	Emission	PAH	1.00E-28			mg	Air	Europe
	Output	Emission	Particles	6531.56002			mg	Air	Europe
	Output	Emission	Pb	2.23E-04			mg	Air	Europe
	Output	Emission	Pb	5.37E-04			mg	Water	Europe
	Output	Emission	Phenol	7.864122413			mg	Water	Europe
	Output	Emission	S2-	0.15307305			mg	Water	Europe
	Output	Emission	SO2	19050.5403			mg	Air	Europe
	Output	Emission	SO42-	23623.92272			mg	Water	Europe
	Output	Emission	Suspended solids	6369.654453			mg	Water	Europe
	Output	Emission	Thiols	2.40E-02			mg	Air	Europe
	Output	Emission	Vinyl chloride	2.35E-25			mg	Water	Europe
	Output	Emission	Vinyl chloride	9.55E-07			mg	Air	Europe
	Output	Emission	VOC	10.48377369			mg	Water	Europe
	Output	Emission	VOC	131.0160613			mg	Air	Europe
	Output	Emission	VOC	192.6427936			mg	Water	Europe
	Output	Emission	VOC	4417.901628			mg	Air	Europe
	Output	Emission	VOC	505.9592401			mg	Air	Europe
	Output	Emission	Zn	2.58E-03			mg	Water	Europe
	Output	Product	TDI (toluene diisocyanat	1			kg	Technosphere	Europe
	Output	Residue	Construction	22.81590315			mg	Ground	Europe
	Output	Residue	Industrial	6923.472655			mg	Ground	Europe
	Output	Residue	Inert chemical	1647.326887			mg	Ground	Europe
	Output	Residue	Metals	27.48717803			mg	Ground	Europe
	Output	Residue	Mineral	124541.8045			mg	Ground	Europe
	Output	Residue	Paper & board	3.127077743			mg	Ground	Europe
	Output	Residue	Plastics	78.28719996			mg	Ground	Europe
	Output	Residue	Regulated chemical	10816.78657			mg	Ground	Europe
	Output	Residue	Slags & ashes	27960.74115			mg	Ground	Europe
	Output	Residue	Unspecified	9.467641545			mg	Ground	Europe
	Output	Residue	Wood waste	3.865873741			mg	Ground	Europe

About Inventory

Publication	''Eco-profiles of the European plastics industry'', report for TDI. ''Eco-profiles of plastics and related intermediates: Methodology'', I. Boustead, The European Centre for Plastics in the Environment of The Association of Plastics Manufacturers in Europe (APME), Brussels, 1999. Reports are available at APME's web site http://lca.apme.org. --- Documented by Caroline Sjöberg and Sofia Haargaard, Volvo Technological Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology Published in SPINE@CPM: 5 September 2001 ---
Intended User	1. APME member companies 2. L
General Purpose	The general purpose of the study was to demonstrate the commitment of APME (Association of Plastics Manufacturers in Europe) to improve the environmental impact of the processes, from extraction of oil to granulate or polymer compound.

Detailed Purpose	Eco-profiles are intended primarily as buiding blocks for use in the construction of complete life cycle analyses. 1. Provide APME member companies with information which will highlight potential areas for improving manufacturing processes, 2. Provide valuable inventory data for downstream users of plastics, such as packaging manufacturers, who will be able to produce their own eco-balance assessments (i.e. LCAs) of individual products. Objectives and areas of application for the Eco-profiles: - Plastics waste management studies - Internal company benchmarking - Product development. Detailed environmental information to customers of APME members for use in improving the overall environmental performance of products and systems. - Ensuring that the data are neutral. The purpose of the 1999 update was to re-issue all of the data sets together using the latest data available and with all of the results forming a consistent data set. Significant technological and commercial changes have occured since 1989-93, the period to which the oldest group of Eco-profile data referred. Also the quality of data reported by the companies has improved since then.
Commissioner	APME - Avenue E. van Nieuwenhuyse 4 Box 3 B-1160 Brussels Belgium.
Practitioner	Boustead, Ian - .
Reviewer	-
Applicability	European average data. Results are based on data supplied by 3 production plants in 6 countries: France, Germany and Italy. Their total production was 372,000 tonnes. The data are calculated on a cradle to gate basis, therefore, nuclear power, coal, limestone etc should be regarded as resources from environment, i.e. no supplier activities should be connected to these flows. Remember that, in an LCA, two systems could only be compared if they perform equivalent functions. For instance, production of 1 kg of polyethylene should not be compared directly with production of 1 kg of polycarbonate. Only in a specific application, a comparison between the two materials could be meaningful. It is not reported how large differences there are between different producers with respect to emissions and other environmental impacts. Therefore, it is also not known how well the data could represent production at a specific plant.
About Data	European average data for TDI production on a cradle to gate basis, issued by APME (Association of Plastics Manufacturers in Europe), and produced in association with the independent expert I. Boustead. The companies participating in the project have supplied data on the chemical processes. Data are probably fairly representative for production of TDI in Europe. However, the reliability of the data depends on the quality of the records maintained by the individual companies. Mass and energy balances have been checked, and the details of all calculations were referred back to individual companies for checking before being incorporated into the final averages. Data for supporting operations and transport have been obtained from other manufacturers and operators as part of an on-going exercise involved in maintaining an LCI database. The quality of data for public electricity production is not described. However, it is stated that information on the production of fuels and energy have been derived from the reports of the International Energy Agency 1996, which contain data for 1995. No other process data have been derived from the literature. The accuracy of data for materials and energy supplied by companies is considered to be about 5-10%. Wastes and emissions are often measured with less accuracy. Even for a regulated emission, the procedure for measuring and reporting is usually based on sampling rather than continuous monotoring. The accuracy is often unknown. Vertical averaging has been applied wherever there have been sufficient data from upstream raw material and fuel producers. In vertical averaging, each production sequence (i.e. each plant + its specific suppliers) is calculated separately, and the final result is the average of the results from the individual production sequences weighted by the output from each production sequence (plant). Horizontal averaging has, however, been applied for some processes over which the producers have no control and data from a specific supplier were not available. In these cases, European average data from the other participants or suppliers were used in the calculations. For fuels and feedstock materials, actual gross calorific values (energy content) have been used in the calculations. Typical values: 45,0 MJ/kg for crude oil, 38,8 MJ/m3 (54,1 MJ/kg) for natural gas, 28,0 MJ/kg for coal, 15,0 MJ/kg for lignite, 9,3 MJ/kg for sulphur. The following degrees of efficiencies have been used to convert electricity production in nuclear plants and hydro plants, respectively, to primary energy equivalents: 35% for nuclear electricity, 80% for hydro electricity. According to the APME methodology report, the amounts of combusted fuels have been corrected by adding the feedstock (gas and oil) residues used as fuel within the processes,

	before calculating the CO_2 emission. CO_2 emission values have been calculated from the composition of the fuel, assuming complete combustion: CO_2 emission = 3,67 x {mass fraction of carbon in fuel}/{calorific value in MJ/kg} (kg/MJ fuel).
Notes	The following substance names have been changed from the nomenclature used by APME to adapt to nomenclature according to CPM report 2000:2. RESOURCES Old name New name Barite (Ba(SO4) Barytes Bauxite (Al2O3*H2O) Bauxite Chromium (Cr3+, Cr6+) Chromium Coal, hard unspecified Hard coal Gravel (unspecified) Gravel Hydro (primary energy) Hydro energy Olivin (unspecified) Olivin Phosphate (as P2O5) Phosphate Potassium chloid Potassium chloride Sand (unspecified) Sand Sulphur (elemental) Sulphur Wood (unspecified) Wood EMISSIONS Old name New name Aluminium ion Al Ammonium ion NH4+ Carbon disulfide CS2 Carbonate CO32- Chlorine Cl2 Chromium oxide CrO3 Copper (Cu+) Cu Ethane, 1-,2-, chloro 1,2-Dichloroethane Fluorine (F2) F2 Hydrocyanic HCN Hydrogen H2 Iron, Fe2+, Fe3+ Fe Mercaptans Thiols Metals (unspecified) Metals Nickel ion (Ni++) Ni Nitrate (NO3) NO3- Oils (unspecified) Oil Organo-Cl Chloroorganics Other organics VOC Particulates (unspecified) Particles Sulfuric acid H2S4 Vinylchloride Vinyl chloride VOC (hydrocarbons) VOC VOC (hydrocarbons, oil) VOC VOC (unspecified origin) m.fl. VOC Zinc, ion (Zn++) Zn Ni (Ni++, Ni3+) Ni

SPINE LCI dataset: Production of TSP fertiliser

Administrative	
Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public

Technical System	
Name	Production of TSP fertiliser
Functional Unit	1 kg of TSP fertiliser (48 % P2O5)
Functional Unit Explanation	TSP fertiliser (triple superphosphate), 48 % P2O5. 1 kg P2O5 = 0,4364 kg P.
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Data are taken from literature and reports on fertiliser production. The text below gives generic information about production of TSP (triple superphosphate) as no specific site has been studied. For further information on what the data represent in this dataset, please see the flow data window. Production of triple superphosphate (TSP) Triple superphosphate is produced by acidulating rock phosphate with phosphoric acid, instead of sulphuric acid as in the phosphoric acid process, and 70 % of the phosphorus in the product is supplied as acid and 30 % as rock (Kongshaug,1998). No gypsum is formed in this production step. There are two different triple superphosphate processes: the two step process and the slurry process. In the two step process a powder is produced in the first step, where the main energy consumption is for rock grinding. The powder is then granulated with steam in the second step. This process is based on phosphoric acid with a concentration of 48 % P2O5. The slurry process is based on phosphoric acid with a concentration of 42 % P2O5 and generally, this process consumes 20 % less energy than the two-step process. However, due to need of very soft rock and problems with unreacted rock in the product, this process is not always preferable. References: Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998.

System Boundaries	
Nature Boundary	Emissions and use of resources due to the production of steam and electricity are not included.
Time Boundary	The literature from which data are taken from is published in 1996 and 1998.
Geographical Boundary	Western Europe.
Other Boundaries	
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	
Method	More than 75 % of the triple superphosphate produced in Europe uses the two step process. According to Kongshaug (1998), energy consumption for this process, 2.0 GJ/t TSP (48% P2O5), has therefore been used as average value for production of triple superphosphate in Western Europe. This value has also been assesses to be representative for many plants outside Western Europe and consequently, also for production of triple superphosphate used in Western Europe. Of the total energy consumption 0.7 GJ/t TSP has been used for evaporation, 0.3 GJ/t TSP for powder production and 1.0 GJ/t TSP for granulation (Kongshaug 1998). The energy consumed due to evaporation has been assumed to be steam and the rest has been assumed to be electricity. See also ''Specif QMetaData''.
Literature Reference	Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France. Personal communication: Jostein Søreide (1998). Hydro Porsgrunn, Norway. +47 35 92 75 75.
Notes	No other data for emission have been found and have therefore not been included.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	1.3			MJ	Technosphere	
Notes: 48 % P2O5.	Input	Refined resource	Phosphoric acid	0.7			kg	Technosphere	
Notes: Commercial rock phosphate (32 % P2O5).	Input	Refined resource	Rock phosphate	0.45			kg	Technosphere	
	Input	Refined resource	Steam	0.7			MJ	Technosphere	
Method: According to UNEP (1996) a modern venturi system can reduce emissions of fluorine to 0.1 kg/t P2O5. Due to lack of other information, 0.1 kg fluorine/t P2O5 has been chosen as an average value for production of triple superphosphates used in Western Europe. Literature: UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France.	Output	Emission	F-tot	0.048			g	Air	
Method: According to UNEP (1996) a modern venturi system can reduce emissions of dust to 0.3-1kg/t product. Due to lack of other information, 0.65 kg dust/t product has been chosen as an average value for production of triple superphosphates used in Western Europe. Literature: UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France.	Output	Emission	Particulates	0.65			g	Air	
Method: Data for emissions of phosphates to water have been taken from information from Hydro Agri. Literature: Personal communication: Jostein Søreide (1998). Hydro Porsgrunn, Norway. +47 35 92 75 75.	Output	Emission	P-tot	0.692			g	Water	

Notes: TSP fertiliser (triple superphosphate, 48 % P2O5).	Output	Product	Phosphorous fertiliser	1			kg	Technosphere	

About Inventory	
Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data are intended to be us
General Purpose	To generate an inventory of emissions and use of resources due to the production of fertilisers used in Sweden and Western Europe.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other, but to generate a thorough inventory of emissions and use of resources due to this production. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The data are applicable for production of TSP fertiliser that is used in Western Europe. The dataset is included in the aggregated dataset for production of TSP fertiliser (cradle to gate).
About Data	The data are gathered from literature and reports on fertiliser production, i.e no specific site has been studied.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Production of TSP fertiliser AGGR

Flow Chart
This data set transparently reported, including a flowchart where each process is individually described

Administrative	
Finished	Y
Date Completed	1999
Copyright	
Availability	

Technical System	
Name	Production of TSP fertiliser AGGR
Functional Unit	1 kg phosphorous fertilizer
Functional Unit Explanation	
Process Type	Cradle to gate
Site	Western Europe
Sector	Materials and components
Owner	Western Europe

Technical system description	The route of production for TSP (triple superphosphate) fertiliser can be seen in the aggregated activity window. For further information on the production processes, please see each included dataset. Emissions from transports, energy consumption and production of steam and electricity have been included in the system by using information and emission factors from the database in LCAiT 3.0. LCAiT 3.0 is a computer programme created by CIT Ekologik in Gothenburg for practitioners of life cycle assessments. Production/consumption of steam is assumed to replace/be produced by combustion of oil (efficiency of 0.90). Oil has been chosen as fuel source, as it in terms of emissions lies between coal and natural gas. Included transports and assumptions made regarding transports are described below (transports cannot be seen in the aggregated activity window). Concerning production of fertilisers used in Western Europe no specific sites have been studied and average distances have therefore been assumed. Since the contributions of transports to total amounts of emissions and use of resources were found to be small in the Swedish case (ref. to published report) where specific transports were included, the West European transports have not been studied in detail. The means of transports have been assumed to consist of boats (ship, bulk carrier) and trains (train, diesel). Due to lack of data, trains driven by diesel has been chosen to represent the transports by train, even though this might not be true in all cases. The distance for transportation of rock phosphate has been assumed to be 2000 km by boat and 500 km by train, as most of the rock phosphate is imported from North Africa and the Kola Peninsula in Russia. It has been assumed that the intermediate product phosphoric acid is produced at a site where it can be used directly in production of fertilisers. Phosphoric acid has therefore not been charged with any transports.

Flowchart

Click on flowchart to open each data set description

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	
Method	More than 75 % of the triple superphosphate produced in Europe uses the two step process. According to Kongshaug (1998), energy consumption for this process, 2.0 GJ/t TSP (48% P2O5), has therefore been used as average value for production of triple superphosphate in Western Europe. This value has also been assesses to be representative for many plants outside Western Europe and consequently, also for production of triple superphosphate used in Western Europe. Of the total energy consumption 0.7 GJ/t TSP has been used for evaporation, 0.3 GJ/t TSP for powder production and 1.0 GJ/t TSP for granulation (Kongshaug 1998). The energy consumed due to evaporation has been assumed to be steam and the rest has been assumed to be electricity. See also ''Specif QMetaData''.
Literature Reference	Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France. Personal communication: Jostein Søreide (1998). Hydro Porsgrunn, Norway. +47 35 92 75 75.
Notes	No other data for emission have been found and have therefore not been included.

Flow Table and Specific Meta Data									
QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Emissions from extraction and final use (combustion) of oil are included in the outputs.	Input	Natural resource	Oil, heavy fuel	2.51E+00			MJ	Ground	
	Input	Natural resource	Phosphorus	0.209			kg	Ground	
Notes: Emissions from production and final use (combustion) of diesel are included in the outputs.	Input	Refined resource	Diesel	1.91E+00			MJ	Technosphere	
Notes: Emissions from production of electricity are included in the outputs.	Input	Refined resource	Electricity	1.76E+00			MJ	Technosphere	Europe
Notes: Emissions from production and final use (combustion) of fuel oil are included in the outputs.	Input	Refined resource	Fuel oil, ship (2-stroke)	2.30E-01			MJ	Technosphere	
	Output	Emission	Al	1.59E-03			g	Water	
	Output	Emission	Aldehydes	1.49E-06			g	Air	
	Output	Emission	Alkanes	1.50E-03			g	Air	
	Output	Emission	Alkenes	7.52E-05			g	Air	
Notes: (C9-C10)	Output	Emission	Aromates	1.25E-05			g	Water	
Notes: (C9-C10)	Output	Emission	Aromates	4.17E-04			g	Air	
	Output	Emission	As	1.55E-05			g	Water	
	Output	Emission	As	4.38E-05			g	Air	
	Output	Emission	B	2.42E-03			g	Air	
	Output	Emission	Benzene	2.50E-03			g	Air	
	Output	Emission	Benzo(a)pyrene	8.96E-08			g	Air	
	Output	Emission	BOD	2.28E-04			g	Water	
	Output	Emission	Ca	2.00E-04			g	Air	
	Output	Emission	Cd	7.87E-06			g	Water	
	Output	Emission	Cd	9.34E-05			g	Air	
	Output	Emission	CH4	1.19E+00			g	Air	
	Output	Emission	Cl-	4.56E+00			g	Water	
	Output	Emission	CN-	1.18E-05			g	Water	
	Output	Emission	CN-	2.51E-05			g	Air	
	Output	Emission	Co	3.01E-06			g	Water	
	Output	Emission	Co	8.86E-05			g	Air	
	Output	Emission	CO	8.90E-01			g	Air	
	Output	Emission	CO2	6.46E+02			g	Air	
	Output	Emission	COD	7.35E-03			g	Water	
	Output	Emission	Cr	3.71E-05			g	Water	
	Output	Emission	Cr	4.40E-05			g	Air	
	Output	Emission	Cr3+	1.78E-05			g	Air	
	Output	Emission	Cr3+	7.57E-05			g	Water	
	Output	Emission	Cu	1.22E-05			g	Water	
	Output	Emission	Cu	2.31E-04			g	Air	
	Output	Emission	Dioxin	5.48E-10			g	Air	
	Output	Emission	Dissolved solids	4.75E-02			g	Water	
	Output	Emission	DOC	3.12E-13			g	Water	
	Output	Emission	F-	1.24E-03			g	Water	
	Output	Emission	Fe	9.91E-02			g	Water	
	Output	Emission	Formaldehyde	1.13E-03			g	Air	
	Output	Emission	F-tot	1.29E-01			g	Air	
	Output	Emission	H+	3.64E-05			g	Water	
	Output	Emission	H2S	2.80E-05			g	Air	
	Output	Emission	H2S	3.87E-07			g	Water	
	Output	Emission	Hazardous waste	4.88E+00			g	Technosphere	
	Output	Emission	HC	4.40E-05			g	Water	
	Output	Emission	HCl	1.78E-02			g	Air	
	Output	Emission	Heavy metals	5.82E-18			g	Air	
	Output	Emission	HF	1.78E-03			g	Air	
	Output	Emission	Hg	1.43E-05			g	Air	
	Output	Emission	Highly active rad ac waste	3.03E-02			g	Technosphere	
	Output	Emission	Industrial waste	7.15E+01			g	Technosphere	
	Output	Emission	Metals	1.21E-06			g	Air	
	Output	Emission	Metals	6.05E-06			g	Water	

	Output	Emission	Mn	2.44E-05			g	Air	
	Output	Emission	Mn	4.75E-05			g	Water	
	Output	Emission	Mo	4.35E-05			g	Air	
	Output	Emission	N2O	6.01E-02			g	Air	
	Output	Emission	Na	1.88E-03			g	Air	
	Output	Emission	NH3	3.06E-04			g	Air	
	Output	Emission	Ni	2.08E-03			g	Air	
	Output	Emission	Ni	5.10E-05			g	Water	
	Output	Emission	NMVOC	1.36E+00			g	Air	
	Output	Emission	NOx	3.84E+00			g	Air	
	Output	Emission	N-tot	2.09E-02			g	Water	
	Output	Emission	Oil	1.30E-01			g	Water	
	Output	Emission	Organics	1.03E-01			g	Water	
	Output	Emission	Organics	3.00E-06			g	Air	
	Output	Emission	PAH	1.26E-06			g	Air	
	Output	Emission	Particulates	1.24E+00			g	Air	
	Output	Emission	Pb	1.95E-04			g	Air	
	Output	Emission	Pb	5.74E-05			g	Water	
	Output	Emission	Phenol	7.81E-15			g	Water	
	Output	Emission	Phosphate	1.18E-04			g	Water	
	Output	Emission	PO43-	2.54E-04			g	Water	
	Output	Emission	Propane	7.52E-05			g	Air	
	Output	Emission	P-tot	6.92E-01			g	Water	
	Output	Emission	Radioactive emissions	4.77E+01			kBq	Water	
	Output	Emission	Radioactive emissions	5.55E+03			kBq	Air	
	Output	Emission	Radioactive waste	1.75E-02			g	Technosphere	
	Output	Emission	Salt	2.21E-01			g	Water	
	Output	Emission	Sb	3.07E-06			g	Air	
	Output	Emission	Sb	4.24E-08			g	Water	
	Output	Emission	Se	6.71E-05			g	Air	
	Output	Emission	Sn	3.32E-03			g	Water	
	Output	Emission	Sn	5.52E-07			g	Air	
	Output	Emission	SO2	8.03E+00			g	Air	
	Output	Emission	SO3	2.78E-01			g	Air	
	Output	Emission	SO42-	7.94E-01			g	Water	
	Output	Emission	Solid waste	7.68E+03			g	Technosphere	
	Output	Emission	Sr	2.36E-04			g	Water	
	Output	Emission	Sr	2.48E-05			g	Air	
	Output	Emission	Susp solids	7.80E-04			g	Water	
	Output	Emission	Th	3.95E-07			g	Air	
	Output	Emission	Tl	6.82E-08			g	Air	
	Output	Emission	Toluene	7.52E-05			g	Air	
	Output	Emission	U	3.80E-07			g	Air	
	Output	Emission	V	7.15E-03			g	Air	
	Output	Emission	V	9.91E-06			g	Water	
	Output	Emission	VOC	8.60E-03			g	Air	
	Output	Emission	Zn	2.07E-04			g	Air	
	Output	Emission	Zn	2.60E-04			g	Water	
Notes: TSP fertiliser (triple superphosphate), 48 % P2O5.	Output	Product	Phosphorous fertiliser	1			kg	Technosphere	

About Inventory	
Publication	
Intended User	
General Purpose	
Detailed Purpose	
Commissioner	
Practitioner	
Reviewer	

Applicability	
About Data	
Notes	

SPINE LCI dataset: Production of turned brass cylinders, 205 kg

Administrative	
Finished	Y
Date Completed	2002
Copyright	
Availability	Public

Technical System	
Name	Production of turned brass cylinders, 205 kg
Functional Unit	One turned brass cylinder, 205 kg
Functional Unit Explanation	One turned brass cylinder, 205 kg, will later be further processed into one brass cage (55,6 kg) used in the SKF spherical roller bearing 232/530.
Process Type	Gate to gate
Site	BecoTek ASIndustriveien 3, NO-3340 ÅMOT NORWAY
Sector	Materials and components
Owner	BecoTek ASIndustriveien 3, NO-3340 ÅMOT NORWAY
Technical system description	This activity describes a process step included in the system ''Production of brass cages used for spherical roller bearings'', also available in the SPINE@CPM database. The turned brass cylinders will serve as raw material for the activity ''Manufacturing of brass cages at SKFs site in Göteborg''. The brass cylinders are supplied by BecoTek AS in Norway. The brass is bought by BecoTek from Olof Manners AB in Mölndal, Sweden. The production of brass is NOT included in this dataset, but must be followed from the cradle for a total environmental impact. The production of turned brass cylinders takes place at BecoTek AS production plant in Åmot, Norway. First the brass is smelted in electric furnaces at the plant in Åmot, Norway. The smelt is then poured into a form and casted into desired shape. The cylinders formed are then turned in a turning machine and finally inspected and packed. All scrap produced in the process is recycled and used in the smelting process as raw material. The energy consumption was reported from BecoTek (= 1.19kWh/kg). Also internal transport by electric truck (40 m for each cylinder) and diesel truck (40 m for each cylinder) were reported. The environmental impact is probably significantly higher since no other inflows or outflows from the process are measured.

System Boundaries	
Nature Boundary	The production of brass is not included in this study, so the inflow of brass is coming from the technosphere. This MUST be accounted for when using the dataset to obtain the total environmental impact. (Data from brassproduction is available e.g. from CIT Ekologik AB, Chalmers) Emissions to water and air are not known for the production of turned brass cylinders in Norway. Only energy consumption (1,19 kWh/kg brass) and internal transport (40 m electric truck and 40 m diesel truck) are included from that process .
Time Boundary	The data is collected during autumn 2002. No changes in the procedure are planned for the nearest future.
Geographical Boundary	The brass cylinders are produced in Åmot, Norway.

Other Boundaries	The electricity production is NOT included. Average European electricity production should be used. Assumptions were made at BeTe Trucks AB in Sweden how much energy a dieseltruck and an electric truck consume per km (=0,75 KWh/km (el) and 0,3 litre/km (diesel)). The heating value for diesel (=35, 31 MJ/litre) was found at Internet: www.fast-tech.com and the diesel consumption could be calculated to 0,42372 MJ/40m. For the internal production with diesel truck and electric truck, the production of diesel and electricity are NOT included. Datasets for production of electricity and diesel can be bought at CIT Ekologik AB, Göteborg.
Allocations	Allocations have been made according to weight for the brass cylinder production. The internal transport is calculated specific for one turned brass cylinder, 205 kg.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Unspecified, guesstimate
Represents	
Method	Data has been gathered from interviews with Eirik Hjerpaasen, BecoTek AS in Åmot, Norway.
Literature Reference	Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France. Personal communication: Jostein Søreide (1998). Hydro Porsgrunn, Norway. +47 35 92 75 75.
Notes	No other data for emission have been found and have therefore not been included.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Brass	205			kg	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Calculated Method: The consumption of energy for the internal transport is calculated from assumptions made by BeTe Truck AB in Sweden. Diesel truck: 0,012 litres / 40 m. Heating Value (diesel) = 35,31 mJ/l. (taken from Data&Diagram, Hellsten Gunnar) ==> 0,42372 MJ/40 m Literature: Mörtstedt Sten-Erik, Hellsten Gunnar; Data och diagram, Energi- och kemitekniska tabeller; Liber Utbildning; 1996.	Input	Refined resource	Diesel	0.42372			MJ	Technosphere	Europe
Date concieved: 02-08-01 - 02-12-31 Data type: Unspecified, guesstimate Method: BecoTek AS estimates the energy consumption from their production plant to 1,19kWh/kg brass. This data also includes the internal transport with electric truck, 40 m. Electric truck: 0,75 kWh/km (assumption from BeTe Truck AB in Sweden) ==> 0,03 kWh/ 40 m.	Input	Refined resource	Electricity	243.93			kWh	Technosphere	Norway
	Output	Product	Brass cylinder	205			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.

General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for production of turned brass cylinders of this weight at the specific site at BecoTek AS in Åmot, Norway.
About Data	Data has been gathered from interviews with Eirik Hjerpaasen, BecoTek AS in Åmot, Norway.
Notes	

SPINE LCI dataset: Production of Urea-formaldehyde resin 1202 (UF 1202), Wood Adhesive

Administrative	
Finished	Y
Date Completed	2000-03-07
Copyright	Casco Products
Availability	Public

Technical System	
Name	Production of Urea-formaldehyde resin 1202 (UF 1202), Wood Adhesive
Functional Unit	1 kg dry urea-formaldehyde resin 1202 (UF 1202)
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg dry urea-formaldehyde resin 1202 (UF 1202). UF 1202 is a wood adhesive and is also namned Cascorit 1202. The wood adhesive is delivered with 70% dry content, of which is 70 % UF, 29,8 % water and < 0,2% free formaldehyde.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Urea-formaldehyde resin 1202 (UF 1202) is a wood adhesive produced by Casco Products, Sweden. The main steps of UF 1202 production are: 1. Natural gas production: The study includes winning, delivery to shore and storage. Natural gas is used in the production of methanol and ammonia. 2. Methanol production: Natural gas is produced into synthesis gas in reformers. Synthesis gas is converted to raw methanol in a catalytic process and distilled into finished methanol. Storage is included. 3. Formalin production: Formalin is produced from methanol by oxidation in the Formox process. 4. Ammonia and urea production: Ammonia is produced from natural gas, air and water in a steam reforming process. In the process carbon dioxide is produced. The urea plant is situated on the same site as the ammonia plant. Urea is produced by reacting ammonia and carbon dioxide at 150 bar at an operation temparature of 185-190°C. The carbon dioxide used in the urea process comes from the

	ammonia process. Excess carbon dioxide is accounted for as emission to air. 4. Formic acid is produced from sodium formate and sulphuric acid with sodium sulphate as a by -product. This flow was not followed to the cradle. 5.Sodium hydroxide is produced from soduim chloride in an electrolythic reaction. 6. UF resin production: In a condensation reaction UF resin is produced from urea and formalin with very small amounts of formic acid and sodium hydroxide to control pH during reaction. A small amount of ammonia is added during the reaction to form triazinones. Vacuum distillation to 70% dry content for 1202 is included. Overall information: Transports are included in the system.

System Boundaries

Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally , in densly populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1997, beeing yearly averages where possible. No great changes after that are estimated. The data from Casco Products factory in Kristinehamn are from 1998.
Geographical Boundary	The production of the raw materials natural gas, ammonia, methanol and urea is made on different sites in Europe. The production of formalin and urea-formaldehyde resin 1202 is made at Casco Products' factory, Kristinehamn, Sweden.
Other Boundaries	The packages for the product are not included in this study. (The main part is delivered in tank trucks) The transportation to the users, use and final desposal of the glue is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included.
Allocations	Emissions and waste at the Kristinehamn factory where the formalin and resin is produced are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there. The steam generated in the formaldehyde process is used elsewhere in the factory. The energy produced is credited the formaldehyde.(See system expansion)
Systems Expansions	The production of formalin from methanol is an exothermic process.The heat produced is used for production of steam, which is utilised in other processes or for heating purposes. This steam replaces steam from oil that would otherwise have been needed. Therefor the steam produced in the process has been credited the formalin, i.e. oil consumption and emisssions were reduced. The amount of oil for production of steam on site and emissions from the boiler is known. (See Product Specific Requirements for Certified EPD for chemical products, www.environdec .com)

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from Environmental Report 1998 and Production Statistics 1998. Allocations were made on mass basis.
Literature Reference	Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France. Personal communication: Jostein Søreide (1998). Hydro Porsgrunn, Norway. +47 35 92 75 75.
Notes	No other data for emission have been found and have therefore not been included.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Coal	0.67			MJ	Ground	

	Input	Natural resource	Crude oil	2.78			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	0.338			MJ	Ground	
	Input	Natural resource	Natural gas	37.03			MJ	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	0.914			MJ	Ground	
	Input	Natural resource	Wood	0.03			MJ	Ground	
	Output	Emission	CO	0.45			g	Air	
	Output	Emission	CO2	1199			g	Air	
	Output	Emission	COD	1.1			g	Water	
	Output	Emission	Dimethylether	0.003			g	Air	
	Output	Emission	Dissolved solids	0.05			g	Water	
	Output	Emission	Dust	1.6			g	Air	
	Output	Emission	Formaldehyde	0.009			g	Air	
	Output	Emission	Formaldehyde	0.06			g	Water	
	Output	Emission	H+	0.05			g	Water	
	Output	Emission	HCl	0.01			g	Air	
	Output	Emission	Hydrocarbons	3.7			g	Air	
	Output	Emission	Methane	12.8			g	Air	
	Output	Emission	Methanol	0.22			g	Air	
	Output	Emission	N total	0.65			g	Water	
	Output	Emission	NH3	0.004			g	Water	
	Output	Emission	NH3	0.28			g	Air	
	Output	Emission	NOx	5.3			g	Air	
	Output	Emission	Oil and fat	0.05			g	Water	
	Output	Emission	SO42-	0.06			g	Water	
	Output	Emission	SOx	4.2			g	Air	
	Output	Emission	Suspended solids	2.1			g	Water	
	Output	Emission	Total organic carbon	0.3			g	Water	
	Output	Emission	VOC	0.04			g	Water	
	Output	Product	UF 1202	1			kg	Technosphere	
	Output	Residue	Hazardous waste	1.8			g	Technosphere	
	Output	Residue	Mineral waste	2.7			g	Technosphere	
	Output	Residue	Mixed industrial waste	0.95			g	Technosphere	
	Output	Residue	Non hazardous waste	24.9			g	Technosphere	
	Output	Residue	Slags and ash	0.4			g	Technosphere	
	Output	Residue	Sludge (Dry matter)	1			g	Technosphere	

About Inventory

Publication	-- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden Published in SPINE@CPM: 7 August 2001 --
Intended User	Users of Wood Adhesive Casco
General Purpose	
Detailed Purpose	To provide LCI data to producers of flooring, carpentry, furniture and other wood products where UF 1202 is used as an adhesive.
Commissioner	- Casco Products Box 11538, S-10061 Stockholm, Sweden .

Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	UF 1202 is a wood adhesive, which must be used with a hardener. There are hardeners for different purposes. It is widely used in the European wood working industry for example for flooring, block glueing, furniture, veneering and so on. It's content of free formaldehyde is <0.2 %. It must be used in hot- or high frequency presses. Data describing three other urea formaldehyde resins (wood adhesives) produced by Casco Products is available in the database; UF 1205, UF 1206 and UF 1274. Hardeners available in the database are Casco Products' Hardener 2545 and Hardener 2580. For more information about adhesives please contact Casco Products, 46 8 743 4000.
About Data	For the production of formaldehyde and UF 1202 all data originates from Casco Products' factory in Kristinehamn. For raw materials suppliers have participated. on terms thet their data will be treated confidentially. For urea and formic acid gate- to- gate data were provided, for methanol and sodium hydroxide gradle -to gateFor ammonia and fuel data from APME Ecoprofiles are used. Raw materials used are mentioned under ''Object of study/Functions) Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1995 from ''Annual Energy Review 1997'' (European comission) Building of the power plant is not included.
Notes	

SPINE LCI dataset: Production of Urea-formaldehyde resin 1205 (UF 1205), Wood Adhesive

Administrative	
Finished	Y
Date Completed	2000-03-07
Copyright	Casco Products
Availability	Public

Technical System	
Name	Production of Urea-formaldehyde resin 1205 (UF 1205), Wood Adhesive
Functional Unit	1 kg dry urea-formaldehyde resin 1205 (UF 1205)
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg dry urea-formaldehyde resin 1205 (UF 1205). UF 1205 is a wood adhesive and is also namned Cascorit 1205. The wood adhesive is delivered with 67% dry content, of which is 67 % UF, 32.3 % water and 0,7% free formaldehyde.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Urea-formaldehyde resin 1205 (UF 1205) is a wood adhesive produced by Casco Products, Sweden. The main steps of UF 1205 production are: 1. Natural gas production: The study includes winning, delivery to shore and storage. Natural gas is used in the production of methanol and ammonia. 2. Methanol production: Natural gas is produced into synthesis gas in reformers. Synthesis gas is converted to raw methanol in a catalytic process and distilled into finished methanol. Storage is included.

	3. Formalin production: Formalin is produced from methanol by oxidation in the Formox process. 4. Ammonia and urea production: Ammonia is produced from natural gas, air and water in a steam reforming process. In the process carbon dioxide is produced. The urea plant is situated on the same site as the ammonia plant. Urea is produced by reacting ammonia and carbon dioxide at 150 bar at an operation temparature of 185-190°C. The carbon dioxide used in the urea process comes from the ammonia process. Excess carbon dioxide is accounted for as emission to air. 4. Formic acid is produced from sodium formate and sulphuric acid with sodium sulphate as a by -product. This flow was not followed to the cradle. 5.Sodium hydroxide is produced from soduim chloride in an electrolythic reaction. 6. UF resin production: In a condensation reaction UF resin is produced from urea and formalin with very small amounts of formic acid and sodium hydroxide to control pH during reaction. Distillation to 67% dry content for 1205 is included. Overall information: Transports are included in the system.

System Boundaries

Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally , in densly populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1997, beeing yearly averages where possible. No great changes after that are estimated. The data from Casco Products factory in Kristinehamn are from 1998.
Geographical Boundary	The production of the raw materials natural gas, ammonia, methanol and urea is made on different sites in Europe. The production of formalin and urea-formaldehyde resin 1205 is made at Casco Products' factory, Kristinehamn, Sweden.
Other Boundaries	The packages for the product are not included in this study. (The main part is delivered in tank trucks) The transportation to the users, use and final desposal of the glue is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included.
Allocations	Emissions and waste at the Kristinehamn factory where the formalin and resin is produced are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there. The steam generated in the formaldehyde process is used elsewhere in the factory. The energy produced is credited the formaldehyde.(See system expansion)
Systems Expansions	The production of formalin from methanol is an exothermic process.The heat produced is used for production of steam, which is utilised in other processes or for heating purposes. This steam replaces steam from oil that would otherwise have been needed. Therefor the steam produced in the process has been credited the formalin, i.e. oil consumption and emisssions were reduced. The amount of oil for production of steam on site and emissions from the boiler is known. (See Product Specific Requirements for Certified EPD for chemical products, www.environdec.com)

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from Environmental Report 1998 and Production Statistics 1998. Allocations were made on mass basis.
Literature Reference	Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France. Personal communication: Jostein Søreide (1998). Hydro Porsgrunn, Norway. +47 35 92 75 75.

Notes	No other data for emission have been found and have therefore not been included.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Coal	0.77			MJ	Ground	
	Input	Natural resource	Crude oil	2.13			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	0.363			MJ	Ground	
	Input	Natural resource	Natural gas	36.68			MJ	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	0.97			MJ	Ground	
	Input	Natural resource	Wood	0.03			MJ	Ground	
	Output	Emission	CO	0.43			g	Air	
	Output	Emission	CO2	1097			g	Air	
	Output	Emission	COD	1.1			g	Water	
	Output	Emission	Dimethylether	0.003			g	Air	
	Output	Emission	Dissolved solids	0.04			g	Water	
	Output	Emission	Dust	1			g	Air	
	Output	Emission	Formaldehyde	0.009			g	Air	
	Output	Emission	Formaldehyde	0.06			g	Water	
	Output	Emission	H+	0.05			g	Water	
	Output	Emission	HCl	0.01			g	Air	
	Output	Emission	Hydrocarbons	2.3			g	Air	
	Output	Emission	Methane	12.3			g	Air	
	Output	Emission	Methanol	0.24			g	Air	
	Output	Emission	N total	0.64			g	Water	
	Output	Emission	NH3	0.003			g	Water	
	Output	Emission	NH3	0.26			g	Air	
	Output	Emission	NOx	4.4			g	Air	
	Output	Emission	Oil and fat	0.05			g	Water	
	Output	Emission	SO42-	0.06			g	Water	
	Output	Emission	SOx	3.3			g	Air	
	Output	Emission	Suspended solids	2.1			g	Water	
	Output	Emission	Total organic carbon	0.33			g	Water	
	Output	Product	UF 1205	1			kg	Technosphere	
	Output	Residue	Hazardous waste	1.8			g	Technosphere	
	Output	Residue	Mineral waste	2.7			g	Technosphere	
	Output	Residue	Mixed industrial waste	0.29			g	Technosphere	
	Output	Residue	Non hazardous waste	33.1			g	Technosphere	
	Output	Residue	Slags and ash	0.4			g	Technosphere	
	Output	Residue	Sludge (Dry matter)	1			g	Technosphere	

About Inventory

Publication	-- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden Published in SPINE@CPM: 7 August 2001 --
Intended User	Users of Wood Adhesive Casco

General Purpose	
Detailed Purpose	To provide LCI data to producers of flooring, carpentry, furniture and other wood products where UF 1205 is used as an adhesive.
Commissioner	- Casco Products Box 11538, S-10061 Stockholm, Sweden .
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	UF 1205 is a wood adhesive, which must be used with a hardener. There are hardeners for different purposes. It is widely used in the European wood working industry for example for flooring, block glueing, furniture, veneering and so on. It's content of free formaldehyde is 0,7 %. It is mostly cured in hot- or high frequency presses, but with suitable hardeners it can also be used at room temperature. There also exist UF glues with lower formaldehyde content that are more common than 1205. Other urea formaldehyde wood adhesives produced by Casco Products available in the database are UF 1206, 1202 and 1274. Hardeners available in the database are Casco Products' Hardener 2545 and Hardener 2580. For more information about adhesives please contact Casco Products, 46 8 743 4000
About Data	For the production of formaldehyde and UF 1205 all data originates from Casco Products' factory in Kristinehamn. For raw materials suppliers have participated on terms that their data will be treated confidentially. For urea and formic acid gate-to gate data were provided, for methanol and sodium hydroxide crdle-to gate. For ammonia and fuel data from APME Ecoprofiles are used. Raw materials used are mentioned under ''Object of study/Function. Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1995 from ''Annual Energy Review 1997'' (European comission) Building of the power plant is not included.
Notes	

SPINE LCI dataset: Production of Urea-formaldehyde resin 1206 (UF 1206), Wood Adhesive

Administrative	
Finished	Y
Date Completed	2000-03-07
Copyright	Casco Products
Availability	Public

Technical System	
Name	Production of Urea-formaldehyde resin 1206 (UF 1206), Wood Adhesive
Functional Unit	1 kg dry urea-formaldehyde resin 1206 (UF 1206)
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg dry urea-formaldehyde resin 1206 (UF 1206). UF 1206 is a wood adhesive and is also namned Cascorit 1206. The wood adhesive is delivered with 65% dry content, of which is 65 % UF, 34.3 % water and 0,7% free formaldehyde.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Urea-formaldehyde resin 1206 (UF 1206) is a wood adhesive produced by Casco Products, Sweden.The main steps of UF production are: 1. Natural gas production:

	The study includes winning, delivery to shore and storage. Natural gas is used in the production of methanol and ammonia. 2. Methanol production: Natural gas is produced into synthesis gas in reformers. Synthesis gas is converted to raw methanol in a catalytic process and distilled into finished methanol. Storage is included. 3. Formalin production: Formalin is produced from methanol by oxidation in the Formox process. 4. Ammonia and urea production: Ammonia is produced from natural gas, air and water in a steam reforming process. In the process carbon dioxide is produced. The urea plant is situated on the same site as the ammonia plant. Urea is produced by reacting ammonia and carbon dioxide at 150 bar at an operation temparature of 185-190°C. The carbon dioxide used in the urea process comes from the ammonia process. Excess carbon dioxide is accounted for as emission to air. 4. Formic acid is produced from sodium formate and sulphuric acid with sodium sulphate as a by -product. This flow was not followed to the cradle. 5.Sodium hydroxide is produced from soduim chloride in an electrolythic reaction. 6. UF resin production: In a condensation reaction UF resin is produced from urea and formalin with very small amounts of formic acid and sodium hydroxide to control pH during reaction. Distillation to 65% dry content for 1206 is included. Overall information: Transports are included in the system.

System Boundaries

Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally , in densly populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1997, beeing yearly averages where possible. No great changes after that are estimated. The data from Casco Products factory in Kristinehamn are from 1998.
Geographical Boundary	The production of the raw materials natural gas, ammonia, methanol and urea is made on different sites in Europe. The production of formalin and urea-formaldehyde resin 1206 is made at Casco Products' factory, Kristinehamn, Sweden.
Other Boundaries	The packages for the product are not included in this study. (The main part is delivered in tank trucks) The transportation to the users, use and final desposal of the glue is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included.
Allocations	Emissions and waste at the Kristinehamn factory where the formalin and resin is produced are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there. The steam generated in the formaldehyde process is used elsewhere in the factory. The energy produced is credited the formaldehyde.(See system expansion)
Systems Expansions	The production of formalin from methanol is an exothermic process.The heat produced is used for production of steam, which is utilised in other processes or for heating purposes. This steam replaces steam from oil that would otherwise have been needed. Therefor the steam produced in the process has been credited the formalin, i.e. oil consumption and emisssions were reduced. The amount of oil for production of steam on site and emissions from the boiler is known. (See Product Specific Requirements for Certified EPD for chemical products, www.environdec.com)

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	
Method	Accounted as an inventory profile. Data from suppliers an litterature were used. For emission and waste data in our own factory data were taken from the Environmental Report 1998 and Production statistics 1998. Allocations were made on mass basis.

Literature Reference	Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France. Personal communication: Jostein Søreide (1998). Hydro Porsgrunn, Norway. +47 35 92 75 75.
Notes	990930/BN

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Coal	0.71			MJ	Ground	
	Input	Natural resource	Crude oil	2.62			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	0.425			MJ	Ground	
	Input	Natural resource	Natural gas	37.3			MJ	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	1.28			MJ	Ground	
	Output	Emission	CO	0.47			g	Air	
	Output	Emission	CO2	1127			g	Air	
	Output	Emission	COD	1.1			g	Water	
	Output	Emission	Dimethylether	0.003			g	Air	
	Output	Emission	Dissolved solids	0.05			g	Water	
	Output	Emission	Dust	1			g	Air	
	Output	Emission	Formaldehyde	0.009			g	Air	
	Output	Emission	Formaldehyde	0.06			g	Water	
	Output	Emission	H+	0.05			g	Water	
	Output	Emission	HCl	0.01			g	Air	
	Output	Emission	Hydrocarbons	2.5			g	Air	
	Output	Emission	Methane	12.5			g	Air	
	Output	Emission	Methanol	0.24			g	Air	
	Output	Emission	N total	0.65			g	Water	
	Output	Emission	NH3	0.004			g	Water	
	Output	Emission	NH3	0.26			g	Air	
	Output	Emission	NOx	4.6			g	Air	
	Output	Emission	Oil and fat	0.05			g	Water	
	Output	Emission	SO42-	0.05			g	Water	
	Output	Emission	SOx	3.6			g	Air	
	Output	Emission	Suspended solids	2.1			g	Water	
	Output	Emission	Total organic carbon	0.32			g	Water	
	Output	Emission	VOC	0.04			g	Air	
	Output	Product	UF 1206	1			kg	Technosphere	
	Output	Residue	Hazardous waste	1.8			g	Technosphere	
	Output	Residue	Mineral waste	2.7			g	Technosphere	
	Output	Residue	Mixed industrial waste	0.4			g	Technosphere	
	Output	Residue	Non hazardous waste	27.1			g	Technosphere	
	Output	Residue	Slags and ash	0.4			g	Technosphere	
	Output	Residue	Sludge (Dry matter)	1			g	Technosphere	

About Inventory

Publication	-- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden Published in SPINE@CPM: 7 August 2001 --
Intended User	Users of Wood Adhesive Casco
General Purpose	The purpose is to determine the environmental impact form cradle to gate for the adhesive so that it is possible to use it in Life Cycle Assessement of glued products like flooring, carpentry, furniture and other wood products where 1206 is used.
Detailed Purpose	There was also an internal interest to identify which segment in the life cycle that contribute most to the impact.
Commissioner	- Casco Products Box 11538, S-10061 Stockholm, Sweden .
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	UF 1206 is a wood adhesive, which must be used with a hardener. There are hardeners for different purposes. It is widely used in the European wood working industry for example for flooring, block glueing, furniture, veneering and so on. It's content of free formaldehyde is 0,7 %. It is mostly cured in hot- or high frequency presses, but with suitable hardeners it can also be used at room temperature. There also exist UF glues with lower formaldehyde content that are more common than 1206. Data describing three other urea formaldehyde resins (wood adhesives) produced by Casco Products is available in the database; UF 1205, UF 1202 and UF 1274. Hardeners available in the database are Casco Products' Hardener 2545 and Hardener 2580. For more information about adhesives, please contact Casco Products, phone no 46 8 743 4000.
About Data	For the production of formaldehyde and UF 1206 all data originates from Casco Products' factory in Kristinehamn. For raw materials suppliers have participated on terms that their data will be treated confidentially. For urea and formic acid gate-to gate data were provided and for methanol and sodium hydroxide cradle-to gate data. For ammonia and fuel data from APME Ecoprofiles are used. Raw materials used are mentioned under ''Object of study/Functions) Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1995 from ''Annual Energy Review 1997'' (European comission) Building of the power plant is not included.
Notes	

SPINE LCI dataset: Production of Urea-formaldehyde resin 1274 (UF 1274), Wood Adhesive

Administrative	
Finished	Y
Date Completed	2000-03-07
Copyright	Casco Products
Availability	Public

Technical System	
Name	Production of Urea-formaldehyde resin 1274 (UF 1274), Wood Adhesive
Functional Unit	1 kg dry urea-formaldehyde resin 1274 (UF 1274)
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg dry urea-formaldehyde resin 1274 (UF 1274). UF 1274 is a wood adhesive and is also namned Cascorit 1274. The wood adhesive is delivered with 70% dry content, of which is 65 % UF, 5 % starch, 29,8 % water and < 0,2% free formaldehyde.

Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Urea-formaldehyde resin 1274 (UF 1274) is a wood adhesive produced by Casco Products, Sweden. The main steps of UF 1274 production are: 1. Natural gas production: The study includes winning, delivery to shore and storage. Natural gas is used in the production of methanol and ammonia. 2. Methanol production: Natural gas is produced into synthesis gas in reformers. Synthesis gas is converted to raw methanol in a catalytic process and distilled into finished methanol. Storage is included. 3. Formalin production: Formalin is produced from methanol by oxidation in the Formox process. 4. Ammonia and urea production: Ammonia is produced from natural gas, air and water in a steam reforming process. In the process carbon dioxide is produced. The urea plant is situated on the same site as the ammonia plant. Urea is produced by reacting ammonia and carbon dioxide at 150 bar at an operation temparature of 185-190°C. The carbon dioxide used in the urea process comes from the ammonia process. Excess carbon dioxide is accounted for as emission to air. 4. Formic acid is produced from sodium formate and sulphuric acid with sodium sulphate as a by -product. This flow was not followed to the cradle. 5.Sodium hydroxide is produced from soduim chloride in an electrolythic reaction. 6. UF resin production: In a condensation reaction UF resin is produced from urea and formalin with very small amounts of formic acid and sodium hydroxide to control pH during reaction. A small amount of ammonia is added during the reaction to form triazinones. Corn starch is added after condensation. Vacuum distillation to 70% dry content for 1274 is included. Overall information: Transports are included in the system.

System Boundaries

Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally , in densly populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1997, beeing yearly averages where possible. No great changes after that are estimated. The data from Casco Products factory in Kristinehamn are from 1998.
Geographical Boundary	The production of the raw materials natural gas, ammonia, methanol and urea and starch is made on different sites in Europe. The production of formalin and urea-formaldehyde resin 1274 is made at Casco Products' factory, Kristinehamn, Sweden.
Other Boundaries	The packages for the product are not included in this study. (The main part is delivered in tank trucks) The transportation to the users, use and final desposal of the glue is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included. Cultivation of corn was not included.
Allocations	Emissions and waste at the Kristinehamn factory where the formalin and resin is produced are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there. The steam generated in the formaldehyde process is used elsewhere in the factory. The energy produced is credited the formaldehyde.(See system expansion)
Systems Expansions	The production of formalin from methanol is an exothermic process.The heat produced is used for production of steam, which is utilised in other processes or for heating purposes. This steam replaces steam from oil that would otherwise have been needed. Therefor the steam produced in the process has been credited the formalin, i.e. oil consumption and emisssions were reduced. The amount of oil for production of steam on site and emissions from the boiler is known. (See product specific rules for Certified EPD for chemical products)

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from Environmental Report 1998 and Production Statistics 1998. Allocations were made on mass basis.
Literature Reference	Kongshaug G (1998). Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Hydro Agri Europe, Norway. EFMA (European Fertilizer Manufacturers' Association) Seminar on EU Legislation and the Legislation Process in the EU relative to Fertilizer, Prague, October 19-21 1998. UNEP (1996). Mineral Fertilizer Production and the Environment, A Guide to Reducing the Environmental Impact of Fertilizer Production. Technical report N° 26. United Nations Environment Programme Industry and the Environment, 39-43 Quai Andre Citroën, 75739 Paris Cedex 15, France. Personal communication: Jostein Søreide (1998). Hydro Porsgrunn, Norway. +47 35 92 75 75.
Notes	990930/BN

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Coal	0.73			MJ	Ground	
	Input	Natural resource	Corn	154			g	Ground	
	Input	Natural resource	Crude oil	3.05			MJ	Ground	
Method: Electricity from hydro power is assumed to be produced with 80% efficiency Notes: Energy needed to produce electricity from hydro power	Input	Natural resource	Hydro energy	0.4			MJ	Ground	
	Input	Natural resource	Natural gas	37.1			MJ	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	1.22			MJ	Ground	
	Input	Natural resource	Other fuel	0.09			g	Ground	
	Input	Natural resource	Wood	0.04			MJ	Ground	
	Output	Emission	CO	0.46			g	Air	
	Output	Emission	CO2	1140			g	Air	
	Output	Emission	COD	3.4			g	Water	
	Output	Emission	Dimethylether	0.003			g	Air	
	Output	Emission	Dissolved solids	0.04			g	Water	
	Output	Emission	Dust	1			g	Air	
	Output	Emission	Formaldehyde	0.009			g	Air	
	Output	Emission	Formaldehyde	0.06			g	Water	
	Output	Emission	H+	0.05			g	Water	
	Output	Emission	HCl	0.01			g	Air	
	Output	Emission	Hydrocarbons	2.6			g	Air	
	Output	Emission	Methane	12.4			g	Air	
	Output	Emission	Methanol	0.24			g	Air	
	Output	Emission	N total	0.64			g	Water	
	Output	Emission	NH3	0.004			g	Water	
	Output	Emission	NH3	0.26			g	Air	
	Output	Emission	NOx	4.7			g	Air	
	Output	Emission	Oil and fat	0.07			g	Water	
	Output	Emission	SO42-	0.07			g	Water	
	Output	Emission	SOx	3.6			g	Air	
	Output	Emission	Suspended solids	2.1			g	Water	
	Output	Emission	Total organic carbon	0.32			g	Water	

	Output	Emission	VOC	0.03			g	Water	
	Output	Product	UF 1274	1			kg	Technosphere	
	Output	Residue	Hazardous waste	1.8			g	Technosphere	
	Output	Residue	Mineral waste	2.7			g	Technosphere	
	Output	Residue	Mixed industrial waste	0.4			g	Technosphere	
	Output	Residue	Non hazardous waste	26.3			g	Technosphere	
	Output	Residue	Slags and ash	0.4			g	Technosphere	
	Output	Residue	Sludge (Dry matter)	1			g	Technosphere	

About Inventory	
Publication	-- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden Published in SPINE@CPM: 7 August 2001 --
Intended User	Users of Wood Adhesive Casco
General Purpose	
Detailed Purpose	To provide LCI data to producers of flooring, carpentry, furniture and other wood products where UF 1274 is used as an adhesive.
Commissioner	- Casco Products Box 11538, S-10061 Stockholm, Sweden .
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	Wood adhesive UF 1274 is a wood adhesive, which must be used with a hardener. There are hardeners for different purposes. It is widely used in the European wood working industry for example for flooring, , furniture, veneering and so on. It's content of free formaldehyde is <0.2 %. It must be used in hot- or high frequency presses. Data describing three other urea formaldehyde resins (wood adhesives) produced by Casco Products is available in the database; UF 1205, UF 1206 and UF 1202. Hardeners available in the database are Casco Products' Hardener 2545 and Hardener 2580.For more information about adhesives, please contact Casco Products, phone no 46 8 743 4000.
About Data	For the production of formaldehyde and UF 1274 all data originates from Casco Products' factory in Kristinehamn. For raw materials suppliers have participated on terms that their data will be treated confidentially. For urea and formic acid gate-to gate data were provided, for methanol, sodium hydroxide and corn cradle-to gate. For ammonia and fuel data from APME Ecoprofiles are used. Raw materials used are mentioned under ''Object of study/Functions) Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1995 from ''Annual Energy Review 1997'' (European comission) Building of the power plant is not included.
Notes	

SPINE LCI dataset: Production of washing soda

Administrative	
Finished	Y
Date Completed	1991-01-01

Copyright	
Availability	Public

Technical System

Name	Production of washing soda
Functional Unit	1 kg
Functional Unit Explanation	1 kg washing soda
Process Type	Gate to gate
Site	
Sector	Consumer goods
Owner	
Technical system description	Production of washing soda.

System Boundaries

Nature Boundary	No such parameters are measured in this study. No emissions from oil combustion is included
Time Boundary	
Geographical Boundary	
Other Boundaries	Observed parameters are electricity and oil consumption Washing soda goes to the technosphere. No transports are included.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991-01-01
Data Type	Unspecified
Represents	
Method	The data is taken from Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden, wich is based on data from Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Literature Reference	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden Sundström G, ''Energiförbrukning och miljöbelastning för distributionssystem för öl och läsk i Sverige'', Miljöbalans Gustav Sundström AB 1990.
Notes	The inputs, (raw-)material, is not known.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: The amount 1671 kWh/tonne soda is recalculated to 6,02 MJ/kg soda in the reference literature.	Input	Refined resource	Electricity	6.02			MJ	Technosphere	
Method: The amount 106 l/tonne soda is recalculated to 4,060 MJ/kg soda in the reference literature.	Input	Refined resource	Oil	4.060			MJ	Technosphere	
	Output	Product	Soda	1			kg	Technosphere	

About Inventory

Publication	Baumann H, Eriksson E, Rydberg T, Tillman A-M ''Life cycle analysis of selected packaging materials. Quantification of environmental loadings.'' Offprint from SOU 1991:77, Chalmers Industriteknik, Göteborg, Sweden. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	To investigate what energy needs and emissions that is connected with the production and use of glass.
Detailed Purpose	To show the energy consumption for production of washing soda.
Commissioner	- Swedish commission of packaging.
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	
Applicability	The emission factors for stationary installations of oil combustion can be found under the activity ''Combustion of oil'' in this database.
About Data	The inputs, (raw-)material, for the production of washing soda is not known.
Notes	

SPINE LCI dataset: Production of Wetfix I (adhesion promoter used in hot mix for asphalt pavement)

Administrative	
Finished	Y
Date Completed	2001-02-13
Copyright	
Availability	Public

Technical System	
Name	Production of Wetfix I (adhesion promoter used in hot mix for asphalt pavement)
Functional Unit	1 kg of Wetfix I
Functional Unit Explanation	To get an idea of the order of magnitude of the functional unit, an example is the model of the asphalt pavement studied in the report: 1235 ton of hot mix are used per layer of 1 km road. The road is 13 m wide. 2 layers are needed for the construction of the road. 3 layers will be added during the maintenance operations over 40 years. Over the life cycle of the asphalt pavement presented in the report, Wetfix I is assumed to be dosed up to 0,4% per weight of bitumen (Worst case scenario). The bitumen part of the hot mix asphalt pavement is 6%. Therefore 240g Wetfix I may be used for 1 ton of hot mix asphalt pavement.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Production of Wetfix I. Wetfix I is an adhesion promoter used in hot mix asphalt pavements. It is a surface-active material that concentrates at the interface between the bitumen and the aggregate''s

surface.

The inventory includes the production of the raw materials as well as the production of the fuels needed. In general all flows are followed from the cradle (nature). The energy and material resources are traced back to the extraction of natural resources.
The production of electricity used in different parts of the system studied have been included. The production of electricity includes operation and maintenance of the power plants and the production of fuel used for the electricity production. National electricity grids has been applied when no spcecific electricity supplier is known.
All transports used inlude the environmental load from cradle to gate: all inputs are tracked to the cradle, being material or energy.. (for instance the fuel production, cradle to gate is included)

The following systems are the most importanat systems included:

1. Production in Stockvik
1.1 Wetfix I is manufactured in Stockvik (outside Sundsvall, Sweden).
¤ Step 1. Production of Wetfix IC
Mixing of the raw materials (TOFA and VEA) and heating.
¤ Step 2. Production of Wetfix I
Mixing of Wetfix IC with the Solvent.

1.2 Steam
The steam used at the Stockvik plant is produced by using a complex fuel mix. The emissions from the steam production are included. The production of the fuels are included in the system when they are not by-products (14%). The steam is supplied by a neighbouring plant.

2. Raw material productions etc.
2.1 VEA
VEA stands for Various Ethylene Polyamines. Ethyleneamines are manufactured in a continuous process by allowing an excess of ammonia to react under high pressure with ethylene dichloride (EDC). Sodium hydroxide and a very small amount of nitrogen are also involved in the process. The end-products are subsequently isolated from the reaction mixture by distillation. The production systems for the raw materials and utilities have been included.

2.2 TOFA
Tall Oil Fatty Acid
Crude tall oil is produced in a pulp mill (sulphate process). It is treated with sulphuric acid and distilled into Tall oil fatty acids, Distilled tall oil and Tall oil rosin. Light oils and pitch are by-products.

2.3 Solvent
The solvent is a by-product. It is not tracked from the cradle because it is considered as a waste stream. According to the supplier, the solvent has almost no commercial value and would be sent for destruction if it was not used as a raw material for Wetfix I.

2.4 IPA
Isopropyl alcohol is used together with water to wash the reactor at the Wetfix I production plant.
The raw material for the production of isopropyl alcohol is propylene. The utilities used at the plant are electricity and steam. The production systems for the raw materials and utilities have been included.

2.5 Nitrogen
To produce nitrogen, air is first cooled using compressors and then separated into oxygen, argon and nitrogen. It is often sent to the user by pipeline.

3. Transports (Some distances are not dipslayed below for reasons of confidentiality)
3.1 Transport of Solvent:
From Germany to Stockvik, Sweden:
Lorry, 40 ton, 50%, Europe XX km
Ferry, , 700-7000 ton, 60%, Sweden 150 km
Train, electric, 50%, Sweden 950 km

3.2 Transport of VEA:
From the Netherlands to Stockvik.
Train, electric, 46%, the Netherlands XX km
Train, diesel, 50%, Europe (DK) 217 km
Ferry, 700-7 000 ton, Sweden 25 km
Train, electric, 50%, Sweden 876 km

¤ The transports Netherlands-Stockvik are estimated with the Michelin website and therefore calculated on a road basis. In reality, the route is using the railway.
¤ The trains are estimated by the Dutch train before the Danish border and EU train before they reach the Swedish border beyond which Swedish train data are used.

3.3 Transport of TOFA:
From the production plant to Stockvik:
Lorry, 40ton, 50%, Sweden.

3.4 Transport of IPA:
From the Netherlands to Stockvik; SE.
Lorry, 40 ton, 70%, Europe XX km

	Ferry 700-7000 ton, 60%, Sweden 25 km Over the total cradle to gate inventory, electricity is required, although the electricity input is tracked to the cradle and its impact is included (emissions and natural resource use), it is of interest to inform about the internal flow of electricity. The total electricity requirements are as follows: Electricity - biomass 0,0619 kWh Electricity - coal 0,3012 kWh Electricity - hydro 0,0435 kWh Electricity - mix 1,0644 kWh Electricity - natural gas 0,6483 kWh Electricity - nuclear 0,0419 kWh Electricity - oil 0,0398 kWh Electricity - wind 5,98e-03 kWh Note that the production of electricity is tracked from the cradle and included in the inventory (as natural resource use, emissions etc.). For litterature references see: ''About data''

System Boundaries

Nature Boundary	In general all energy and raw material resources are tracked back to the extraction of the natural resource. No emissions from the Wetfix I production site are included because the quantity of process water sent to incineration is negligible compared to other feeds and because no emissions is measured at the reactor. The emissions derived from the heat and electricity use is however included. Crude tall oil is a waste stream from pulp mills and is used as a raw material for Tall oil Fatty Acid. It is not tracked from the cradle because natural resource use, emissions etc. are allocated to the production of pulp. The treatment of crude tall oil with sulphuric acid and the distillation of crude tall oil are however included. A solvent is one of the raw materials for Wetfix I. It is not tracked from the cradle because it is considered as a waste stream. According to the supplier, the solvent has almost no commercial value and would be sent for destruction if it was not used as a raw material for Wetfix I. Different environmental impact due to different emissions in different geographical locations have not been taken into accont. All environmental flows of one substance from different locations have been added to one figure.
Time Boundary	Data for the production of Wetfix I and its raw materials are applicable for 2000. Data on transport were published in 2000. Some average data used upstream in the life cycle inventory were published in 1999 and compiled from data over 1992-1997. Data for different electricity grids are from 1997 and data for the different electricity production systems were published in 1996.
Geographical Boundary	The production site for the final product, Wetfix I, takes place in Stockvik, Sweden. The production sites of the raw materials are in the Netherlands (VEA) and Sweden (TOFA). For the solvent, only the transport to the Wetfix I production site was taken into account (see the ''Nature boundary'' field). IPA is produced in Holland and nitrogen in Sweden.
Other Boundaries	The environmental influence caused by the production of machines, industrial plants and infrastructure is not included. The transport of the different fuels from refinerys to the vehicle or the plant where it is combusted are not included. VEA The transport of nitrogen is not included. It may be performed by pipeline. The transport of the other raw materials i.e. sodium hydroxide, dichloroethane and ammonia are included. IPA The transport of propylene is not included in the system.
Allocations	VEA: Mass allocation.on the products from the distillation. TOFA: Mass allocation on the products from the distillation. The by-products therefore recieve no environmental load.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	2001-02-13

Data Type	Derived, unspecified
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	Data are from the appendix no. 4 in the litterature reference.
Literature Reference	RIES Adeline - ''Life cycle assessment of an adhesion promoter used in hot mix for asphalt pavement'' - Akzo Nobel / Chalmers University of Technology - 2001.
Notes	For 1 kg of hot mix, 0,24 g of Wetfix I are required according to the maximum dosage. For the amount of hot mix required for 1km of road, refer to the ''Functional unit explenation'' in the technical system.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Bauxite	0.1762271			g	Ground	
	Input	Natural resource	Biomass	0.6818711			MJ	Ground	
	Input	Natural resource	Coal	3.179046			MJ	Ground	
	Input	Natural resource	Copper ore	0.1331054			g	Ground	
	Input	Natural resource	Crude oil	16.5871			MJ	Ground	
	Input	Natural resource	Dolomite	8.662664E-03			g	Ground	
	Input	Natural resource	Fuel wood	3.125884E-02			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power. Method: Electricity from hydro power is assumed to be produced with 80% efficiency.	Input	Natural resource	Hydro energy	0.5663094			MJ	Ground	
	Input	Natural resource	Hydrogen	0.3799			MJ	Ground	
	Input	Natural resource	Iron ore	0.3047025			g	Ground	
	Input	Natural resource	Lead ore	1.376373E-03			g	Ground	
	Input	Natural resource	Lignite	0.2267666			MJ	Ground	
	Input	Natural resource	Limestone	3.88057			g	Ground	
	Input	Natural resource	Natural gas	37.33438			MJ	Ground	
	Input	Natural resource	Nitrogen	10.59071			g	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant. Method: Electricity from nuclear power is assumed to be produced with 35% efficiency.	Input	Natural resource	Nuclear energy	2.303878			MJ	Ground	
	Input	Natural resource	Olivine	1.417487E-03			g	Ground	
	Input	Natural resource	Phosphate rock	0.0004			g	Ground	
	Input	Natural resource	Pitch fuel	0.1369394			MJ	Ground	
	Input	Natural resource	Potassium chloride	3.008676			g	Ground	
	Input	Natural resource	Sand	0.2314585			g	Ground	
	Input	Natural resource	Sodium chloride	807.7772			g	Ground	
	Input	Natural resource	Sulphur in ore	5.121142E-02			kg	Ground	
	Input	Natural resource	Wind energy	2.154175E-02			MJ	Ground	
Represents: Waste stream from the pulp mill, used as a raw material for Tall oil Fatty Acid after treatment. Not tracked from the cradle because natural	Input	Refined resource	Crude tall oil	0.7046094			kg	Technosphere	

resource use, emissions etc. are allocated to the production of pulp. Notes: The treatment of crude tall oil with sulphuric acid and the distillation of crude tall oil are included.									
Represents: Raw material for Wetfix I. Not tracked to the cradle because it is considered as a waste stream. Notes: According to the supplier the solvent have almost no commercial value and would be sent for destruction if it was not used as a raw material for Wetfix I.	Input	Refined resource	Solvent	0.2			kg	Technosphere	
	Output	Emission	1,2-Dichloroethane	0.1636356			g	Air	
	Output	Emission	1,2-Dichloroethane	7.81491E-04			g	Water	
	Output	Emission	Acid as H+	2.754831E-02			g	Water	
	Output	Emission	As	1.375166E-05			g	Water	
	Output	Emission	BOD	0.0317848			g	Water	
	Output	Emission	CFCs	3.516589E-03			g	Air	
	Output	Emission	Cl-	19.69787			g	Water	
	Output	Emission	Cl2	3.178361E-02			g	Air	
	Output	Emission	CN-	9.052811E-06			g	Water	
	Output	Emission	CO	1.324983			g	Air	
	Output	Emission	CO2	3.059587			kg	Air	
	Output	Emission	COD	0.3618074			g	Water	
	Output	Emission	Dissolved organics	0.2311783			g	Water	
	Output	Emission	Dissolved solids	16.93191			g	Water	
	Output	Emission	Dust	6.747739E-03			g	Air	
	Output	Emission	Fe++/Fe+++	3.516589E-03			g	Water	
	Output	Emission	H2S	2.986447			g	Air	
	Output	Emission	HC	1.703463E-02			g	Water	
	Output	Emission	HCl	5.693772E-02			g	Air	
	Output	Emission	Hg	0.1338005			mg	Air	
	Output	Emission	Hg	6.128568E-06			g	Water	
	Output	Emission	Hydrocarbons	1.854738			g	Air	
	Output	Emission	Metals	3.295622E-02			g	Water	
	Output	Emission	Methane	5.807564			g	Air	
	Output	Emission	N total	0.2867245			g	Water	
	Output	Emission	N2O	7.529266E-03			g	Air	
	Output	Emission	Na+	9.088233			g	Water	
	Output	Emission	NH3	5.366558E-04			g	Water	
	Output	Emission	NH3	9.329168E-02			g	Air	
	Output	Emission	NH4+	1.197453E-03			g	Water	
	Output	Emission	NO3-	3.963158E-04			g	Water	
	Output	Emission	NOx	10.60665			g	Air	
	Output	Emission	Oil	1.920403E-02			g	Water	
	Output	Emission	P total	1.396318E-04			g	Water	
	Output	Emission	PAH	1.953688E-03			g	Air	
	Output	Emission	Particles	1.20584			g	Air	
	Output	Emission	Pb	4.212276E-03			mg	Air	
	Output	Emission	Pb	4.212276E-03			mg	Water	
	Output	Emission	Phenol	6.39627E-03			g	Water	
	Output	Emission	SO2	11.53226			g	Air	
	Output	Emission	SO42-	2.030535			g	Water	
	Output	Emission	Suspended solids	4.339788			g	Water	
	Output	Emission	Vinyl chloride	0.0390735			g	Air	
	Output	Product	Wetfix I	1			kg	Technosphere	
	Output	Residue	Catalyst waste	1.325922E-02			g	Technosphere	
	Output	Residue	Chemical waste	5.202659			g	Technosphere	
	Output	Residue	Construction waste	1.541514E-02			g	Technosphere	

	Output	Residue	Hazardous waste	6.207702			g	Technosphere	
	Output	Residue	Highly radioactive waste	1.896337E-03			g	Technosphere	
	Output	Residue	Mineral waste	15.04075			g	Technosphere	
	Output	Residue	Mixed industrial waste	2.676498			g	Technosphere	
	Output	Residue	Non hazardous waste	11.4756			g	Technosphere	
	Output	Residue	Oil waste	1.297924E-02			g	Technosphere	
	Output	Residue	Sulphur waste	2.180432E-02			g	Technosphere	
	Output	Residue	Waste to incineration	5.133727E-04			g	Technosphere	

About Inventory	
Publication	RIES Adeline - ''Life cycle assessment of an adhesion promoter used in hot mix for asphalt pavement'' - Akzo Nobel / Chalmers University of Technology - 2001. --- Data documented by: Adeline Ries, Master of Science thesis worker at Akzo Nobel Surface Chemistry Internal review at Akzo by: Klas Hallberg, Akzo Nobel Surface Chemistry Documentation review at CPM by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	Akzo Nobel Surface Chemistry.
General Purpose	The purpose is to determine the environmental impact from the adhesion promoter Wetfix I so that it is possible to compare its impact with the impact from the life of a hot mix asphalt pavement, where Wetfix I may be uesd, on an average Swedish countryside road. Then calculations can show how much the asphalt additive needs to extend the life of the asphalt pavement for the whole system to have a lower environmental load. If the adhesion promoter does not extend the life of the road at all an addition of it will simply increase the environmental load.
Detailed Purpose	To assess the environmental impact of a mass unit of adhesion promoter. To calculate the contribution of the adhesion promoter to the total impact from the asphalt pavement. To identify the segments of the life cycle that contribute most to the impact. To use the results of the study and seek improvement possibilities.
Commissioner	- Akzo Nobel Surface Chemistry AB 444 85 Stenungsund Sweden.
Practitioner	Ries, Adeline - 47bis rue Saint Georges F-37210 Rochecorbon France.
Reviewer	Ramnäs, Olle - Chemical Environmental Science Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	Production of Wetfix I at the Akzo Nobel Stockvik plant, Sweden. Other adhesion promoters may have a completely different eco-profile.
About Data	Most electricity used correspond with the Swedish average (electricity grid from 1999 and inventory for each electricity production published in 1997) [Brännström-Norberg et al., 1996], [Brännström, 1998] and [Directorate general for energy, 1999]. For the electricity used in other countries (Holland etc.) respective electricity grids [Directorate general for energy, 1999] are used. Some fuels used are derived from Statoil activities in Norway (North-Sea extraction of crude oil, production of fuel...) [Statoil, 1999] Productions and transport: 1. Wetfix I production - Data for the production and the steam used were retrieved from Site Stockvik. 2.1 VEA - The inventory data were given by the competent personnel at the production site. EDC The data were derived from the European average value for the production of Vinyl Chloride Monomer [APME, 1999], with a mass allocation on the products of the process (VCM, ethylene and ethylene dichloride) using the ratio given by the competent personnel at the production site. Ammonia The data are approximated by the European average [APME, 1999]: three plants in France, Germany and in the U.K Nitrogen The data are derived from the inventory for the AGA production in Stenungsund, Sweden with the Dutch electricity average instead of the Swedish values. Sodium Hydroxide

	The data are derived from the inventory for the Akzo Nobel Base production in Bohus, Sweden with the Dutch electricity average instead of the Swedish values. 2.2 TOFA - Data retrieved from the Swedish supplier 2.3 Solvent - Information comes from the supplier 2.4 IPA Data at the plant are given by the competent personnel at the production site in Holland. The propylene production is approximated by the European average data from Austria, Belgium, France, Italy, The Netherlands, Norway, Sweden, Portugal and the UK. [APME, 1999] The electricity production is approximated by the Dutch average electricity grid [Directorate general for energy, 1999] composed of the basic electricity production data from the Vattenfall dataset [Brännström-Norberg et al., 1996]. The steam production is approximated by the data for the on-site steam in the Akzo Nobel plant of Herkenbosch, The Netherlands. 2.5 Nitrogen - Data retrieved from the Swedish supplier 3. Transport data used are for average vehicles [NTM, 2000] The references mentioned above: [APME, 1999] APME - publication of ecoprofiles by Boustead consulting - 1999. [Brännström-Norberg et al., 1996] BRÄNNSTRÖM-NORBERG B-M., DETHLEFSEN U., JOHANSSON R., SETTERWALL C., TUNBRANT S. - ''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'' -1996 - Vattenfall AB pp 130. [Brännström, 1998] BRÄNNSTRÖM-NORBERG BRITT-MARIE - ''LCA för kol-Sammanfattnin goch jämförelse med Vattenfalls övriga livscykelanalyser för elproduction'' - 1998 - Vattenfall - pp 11. [Directorate general for energy, 1999] Directorate general for energy (DG XVII) - ''Annual energy review'' - 1999 [NTM, 2000] NTM - NÄTVERKET FÖR TRANSPORTER OCH MILJÖN - ''Network for Transport and the Environment'' - www.ntm.a.se - 2000. [Statoil, 1999] STATOIL - ''Annual Report 1999'' - 1999 - HES Accounting (available on the web)
Notes	The publication reports the results of the study of a system which includes the construction of the asphalt pavement and its maintenance over 40 years. In that system, the adhesion improver Wetfix I is used in the hot mix. Some exact names of raw materials, suppliers and exact transport distances are not shown for reasons of confidentiality. The person stated as Reviewer were the examiner for the Master of Science thesis.

SPINE LCI dataset: Production of Wine Ethanol Fuel (ETAMAX D), excluding grape cultiv. and wine prod.

Administrative	
Finished	Y
Date Completed	1999-01-20
Copyright	
Availability	Public.

Technical System	
Name	Production of Wine Ethanol Fuel (ETAMAX D), excluding grape cultiv. and wine prod.
Functional Unit	1 kg

Functional Unit Explanation	All emissions, resource exploits and energy consummations are based on 1 kg of pure wine ethanol fuel (ETAMAX D).
Process Type	Cradle to gate
Site	Sweden
Sector	Fuel
Owner	Sweden
Technical system description	ETAMAX D is the term used for pure ethanol fuel used for buses in Sweden in 1998. The fuel consists of (in percentage by weight): 95 % Ethanol made from European wine surplus (90,2 %) Beraid 3540 (ignition improver) (7%) Methyl tert-butyl ether (denaturation agent) (2%) Iso-butanol (denaturation agent) (0,5%) Morpholine (corrosion inhibitor) (125 ppm) Distillation of wine to ethanol take place in Italy. The raw ethanol from the distillation is shipped to Sweden (Sekab, Örnsköldsvik) where it is distilled further to reduce its aldehyde and sulphur content. When the concentration of ethanol has reached 95%, the fuel is mixed with the additives. Emissions and energy demands for the following processes are included: -Distillation (the wine is distilled in a one column distillation plant, which requires steam and electricity, partly produced from biogas from the grape shales and branches) -Purification (the raw ethanol is distilled to a higher alcohol concentration, steam and electricity is required for the process) -Production of fuel additives -Combustion of fuel in bus engine (the fuel is combusted in a Scania bus engine, specially developed for ethanol fuel) -Transports (50% filling coefficient) All energy sources are traced back to the extraction of energy raw material. For the processes in Sweden, the petrochemical raw material extraction is assumed to take place in Norway. For raw materials connected to energy use in other countries, a world average is used. The electricity profile is based on the electricity profile for each country respectively. The electricity raw materials are traced back to the extraction in the same way as energy raw material not used for electricity production.

System Boundaries

Nature Boundary	The fact that emissions on different geographical places can have different effects on the environment has not been accounted for. Only CO2 emissions with fossil origin are accounted for. The influence on ground and water is only dealt with in steps where data could be obtained, and are therefore not comprehensive. Only the emissions to air are complete, why these data are the only ones presented.
Time Boundary	All data are for the wine ethanol fuel situation of 1998. Some data were extracted in 1997, but most of them in 1998. Exceptions are energy data which date back to 1993 (energy raw material extraction) and 1995 (electricity profiles).
Geographical Boundary	The study is based on production and consumption of ETAMAX D in Sweden. The ethanol is produced in Italy. All additives are produced in Sweden, except for morpholine, which is not accounted for due to the small amount in the fuel.
Other Boundaries	Subsystems excluded from the system: - environmental influence caused by the production of machines, industrial plants and infrastructure is not included - production and emissions from morpholine (fuel additive) - production and emissions of chemicals used for the distillation process
Allocations	Allocation is made on a mass basis, where allocation has been applied, i.e. cracker product production. The basis for allocation was chosen because it was considered equal in relevance to other possible bases (for example energy basis), but easier to apply. Emissions, resource exploits and energy consumption from the grape cultivation and the wine production are NOT allocated to the wine surplus from which ethanol is made. The motivation is that the surplus would exist irrespectively.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	Data from literature reference.
Literature Reference	M. Ericson, G. Odéhn; ''A Life-Cycle Assessment on Ethanol Fuel from Wine''; Akzo Nobel/Chalmers University of Technology; 1999
Notes	For 1 kg of hot mix, 0,24 g of Wetfix I are required according to the maximum dosage. For the amount of hot mix required for 1km of road, refer to the ''Functional unit explenation'' in the technical system.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Energy resource.	Input	Natural resource	Biomass	6.03			MJ	Ground	
Notes: Energy resource.	Input	Natural resource	Coal	0.023			MJ	Ground	
Notes: Both raw material and energy requirements are included.	Input	Natural resource	Crude oil	7.6			MJ	Ground	
Notes: Both raw materail and energy requirements are included.	Input	Natural resource	Natural gas	5.75			MJ	Ground	
Notes: Is included as ''MJ'' in ''Nuclear''.	Input	Natural resource	Uranium ore	0.039			kg	Ground	
	Output	Emission	CO	0.7			g	Air	
Notes: Fossil emissions of CO2.	Output	Emission	CO2	0.46			kg	Air	
	Output	Emission	HC	0.7			g	Air	
	Output	Emission	NOx	0.0083			kg	Air	
	Output	Emission	Particles	0.4			g	Air	
	Output	Emission	SO2	0.0038			kg	Air	
	Output	Product	ETAMAX D	1			kg	Technosphere	

About Inventory

Publication	M. Ericson, G. Odéhn; ''A Life-Cycle Assessment on Ethanol Fuel from Wine''; Akzo Nobel/Chalmers University of Technology; 1999 --- Data documented by: Malin Ericson, Akzo Nobel Surface Chemistry Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	Akzo Nobel Surface Chemistry.
General Purpose	The purpose was to study the production of wine ethanol fuel for buses in order to track down where the largest environmental charges could be found. Since the ethanol and the ignition improver are the major components of the fuel, it was of interest to focus on their environmental impact. The commissioner of the study (Akzo Nobel) might have a possibility to affect the production of the ignition improver.
Detailed Purpose	- To identify the environmental impacts of using ethanol fuel for buses, and compare the results to already existing LCA:s on other fuels - To track down the steps in the life-cycle with the largest environmental impacts - To identify the contribution of the ignition improver to the total environmental impacts - To use the results of the study as an indication to where to find improvement possibilities
Commissioner	- Akzo Nobel Surface Chemistry.
Practitioner	Ericson, Malin and Gabriella Odéhn - Akzo Nobel Surface Chemistry.
Reviewer	Ramnäs, Olle - Chalmers University of Technology Department of Chemical Environmental Science
Applicability	The data from the study are applicable for the fuel ETAMAX D, if all the ethanol in the fuel is produced form surplus wine from Italy. It is possible to add emission data from a specific bus driven on ETAMAX D in the purpose of studying the environmental impact from that particular bus. It is also possible to compare the wine ethanol fuel to other fuels. If this is done, the boundaries and allocation methods of the compared studies must be the same as for the wine ethanol fuel study. If the boundaries and allocation differ for different studies, these studies can not be considered comparable.

	It was shown that one of the largest singel environmental impacts of the life-cycle of wine ethanol fuel was the transport of the raw ethanol from Italy to Sweden. Chosing a different transport, for example a boat with cleaning devices for exhaust gas, would strongly affect the result. There are other fuels where wine ethanol is a component, but ETAMAX D is the only pure ethanol fuel in Sweden today (1998). The ethanol in ETAMAX D does not necessarily have to come from wine, though this is the origin of ethanol used in bus fuel at present time.
About Data	All production data have been obtained from technicians or sales managers of the different companies involved. In order to receive reliable data for wine ethanol, several distilleries, wine producers and grape cultivators were visited on the sites of production. Data for the grape cultivation have the highest uncertainties due to the fact that weather conditions and cultivation areas (flat or hilly cultivation) will strongly affect the fertiliser and fuel use. The greater part of all data originates from report to authoroties and environmental reports. An exception is the production of Beraid 3540. During the production of this additive, measurements were carried out on site. Discussions with technicians at Akzo Nobel have been carried out to a greater extent than for other companies involved. Data for electricity, where the electricity have been bought from the state net, is based on the electricity profile for the country in question (profile from 1995). The energy raw materials for electricity production are traced back to the extraction in the same way as for fuels which are not used for electricity production. For petrochemical raw materials used in Sweden, the raw material extraction is assumed to take place in Norway. For petrochemical raw materials used in other parts of the world, a world average is used. Data for transportation are average data for long distance transports in Sweden, applicalble for trucks produced 1995 or later. Since most raw materials are bulk chemicals, quite new catalyst equipped vehicles and empty returns are assumed. For transportations in Italy, older trucks without catalysts are assumed. For the boat transport of raw ethanol from Italy to Sweden, the data were collected from the particular shipping company. The electricity consumption for the system is not displayed in the activity/flow meta data, since electricity is produced within the system and therefore does not represent one of the outflows/inflows from/to the system. However, the consumption of electricity has been calculated to be 0.56 MJ/kg ETAMAX D, from which 0.15 MJ derive from hydro power and 0.12 MJ derive from nuclear power.
Notes	The report on the study of wine ethanol fuel is the result of a Master of Science thesis carried out in co-operation with Akzo Nobel Surface Chemistry and Chalmers University of Technology. Olle Ramnäs, Chalmers University of Technology, who is mentioned as reviewer of the study, was the examiner of the final thesis. The final thesis report comprises a cradle to grave study, not a cradle to gate study, which is the type of study described here. The purpose of excluding the combustion of the fuel here, is to leave the user of the data the possibility to use any emission data from ethanol buses. The report also displays a comparison of wine ethanol fuel to diesel, natural gas and ethanol from wheat and wood.

SPINE LCI dataset: Production of Wine Ethanol Fuel (ETAMAX D), including grape cultiv. and wine prod.

Administrative	
Finished	Y
Date Completed	1999-01-20
Copyright	
Availability	Public.

Technical System	
Name	Production of Wine Ethanol Fuel (ETAMAX D), including grape cultiv. and wine prod.
Functional Unit	1 kg
Functional Unit Explanation	All emissions, resource exploits and energy consummations are based on 1 kg of pure wine ethanol fuel (ETAMAX D).
Process Type	Cradle to gate

Site	Sweden
Sector	Fuel
Owner	Sweden
Technical system description	ETAMAX D is the term used for pure ethanol fuel used for buses in Sweden in 1998. The fuel consists of (in percentage by weight): 95 % Ethanol made from European wine surplus (90,2 %) Beraid 3540 (ignition improver) (7%) Methyl tert-butyl ether (denaturation agent) (2%) Iso-butanol (denaturation agent) (0,5%) Morpholine (corrosion inhibitor) (125 ppm) Grape cultivation, wine manufacturing and distillation of wine to ethanol take place in Italy. The raw ethanol from the distillation is shipped to Sweden (Sekab, Örnsköldsvik) where it is distilled further to reduce its aldehyde and sulphur content. When the concentration of ethanol has reached 95%, the fuel is mixed with the additives. Emissions and energy demands for the following processes are included: -Harvesting and spreading of fertilisers during the grape cultivation (the grapes are cultivated in northern Italy and most of the harvesting is done by hand, the fertilisers are spread with different types of agricultural machines). -Production of fertilisers (the fertilisers are produced in Italy) -Wine production (only electricity is used for the process which includes all the steps from grinding to barrel packing) -Production of help chemicals for wine production (the chemicals are produced in Italy) -Distillation (the wine is distilled in a one column distillation plant, which requires steam and electricity, partly produced from biogas from the grape shales and branches) -Purification (the raw ethanol is distilled to a higher alcohol concentration, steam and electricity is required for the process) -Production of fuel additives -Combustion of fuel in bus engine (the fuel is combusted in a Scania bus engine, specially developed for ethanol fuel) -Transports (50% filling coefficient) All energy sources are traced back to the extraction of energy raw material. For the processes in Sweden, the petrochemical raw material extraction is assumed to take place in Norway. For raw materials connected to energy use in other countries, a world average is used. The electricity profile is based on the electricity profile for each country respectively. The electricity raw materials are traced back to the extraction in the same way as energy raw material not used for electricity production.

System Boundaries

Nature Boundary	The fact that emissions on different geographical places can have different effects on the environment has not been accounted for. Only CO2 emissions with fossil origin are accounted for. The influence on ground and water is only dealt with in steps where data could be obtained, and are therefore not comprehensive. Only the emissions to air are complete, why these data are the only ones presented.
Time Boundary	All data are for the wine ethanol fuel situation of 1998. Some data were extracted in 1997, but most of them in 1998. Exceptions are energy data which date back to 1993 (energy raw material extraction) and 1995 (electricity profiles).
Geographical Boundary	The study is based on production and consumption of ETAMAX D in Sweden. The ethanol is produced in Italy. All additives are produced in Sweden, except for morpholine, which is not accounted for.
Other Boundaries	Subsystems excluded from the system: - environmental influence caused by the production of machines, industrial plants and infrastructure is not included (- production of pesticides and the emissions from pesticides from the grape cultivation - production and emissions from morpholine (fuel additive) - production and emissions of chemicals used for the distillation process
Allocations	Allocation is made on a mass basis, where allocation has been applied, i.e. on fertiliser production and cracker product production. The basis for allocation was chosen because it was considered equal in relevance to other possible bases (for example energy basis), but easier to apply.

Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1993-1998
Data Type	Derived, unspecified
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	LCI data are taken from the literature reference. The calculations were carried out by the software tool Ecolab, a program specially designed according to the SPINE standard.
Literature Reference	M. Ericson, G. Odéhn; ''A Life-Cycle Assessment on Ethanol Fuel from Wine; Akzo Nobel/Chalmers University of Technology; 1999
Notes	For 1 kg of hot mix, 0,24 g of Wetfix I are required according to the maximum dosage. For the amount of hot mix required for 1km of road, refer to the ''Functional unit explenation'' in the technical system.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Energy resource.	Input	Natural resource	Biomass	6.03			MJ	Ground	
Notes: Energy resource.	Input	Natural resource	Coal	0.52			MJ	Ground	
Notes: Both raw material and energy requirements are included.	Input	Natural resource	Crude oil	21.9			MJ	Ground	
Notes: Raw material.	Input	Natural resource	Grapes	11.2			kg	Ground	
Notes: Both energy and raw material requirements are included.	Input	Natural resource	Natural gas	10.02			MJ	Ground	
Notes: Is presented in ''MJ'' in ''Nuclear''.	Input	Natural resource	Uranium ore	46.6			g	Ground	
	Output	Emission	CO	2.3			g	Air	
Notes: Fossil emissions of CO2.	Output	Emission	CO2	1.87			kg	Air	
	Output	Emission	HC	1.5			g	Air	
	Output	Emission	NOx	16.1			g	Air	
	Output	Emission	Particles	0.8			g	Air	
	Output	Emission	SO2	7			g	Air	
	Output	Product	ETAMAX D	1			kg	Technosphere	

About Inventory

Publication	M. Ericson, G. Odéhn;'' A Life-Cycle Assessment on Ethanol Fuel from Wine''; Akzo Nobel/Chalmers University of Technology; 1999 -- Data documented by: Malin Ericson, Akzo Nobel Surface Chemistry Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Akzo Nobel Surface Chemistry.
General Purpose	The purpose was to study the production of wine ethanol fuel for buses in order to track down where the largest environmental charges could be found. Since the ethanol and the ignition improver are the major components of the fuel, it was of interest to focus on their environmental impact. The commissioner of the study (Akzo Nobel) might have a possibility to affect the production of the ignition improver.
Detailed Purpose	- To identify the environmental impacts of using ethanol fuel for buses, and compare the results to already existing LCA:s on other fuels - To track down the steps in the life-cycle with the largest environmental impacts - To identify the contribution of the ignition improver to the total environmental impacts - To use the results of the study as an indication to where to find improvement possibilities
Commissioner	- Akzo Nobel Surface Chemistry.
Practitioner	Ericson, Malin and Gabriella Odéhn - Akzo Nobel Surface Chemistry.
Reviewer	Ramnäs, Olle - Chalmers University of Technology Department of Chemical Environmental Science

	Applicability	The data from the study are applicable for the fuel ETAMAX D, if all the ethanol in the fuel is produced form surplus wine from Italy. It is possible to add emission data from a specific bus driven on ETAMAX D in the purpose of studying the environmental impact from that particular bus. It is also possible to compare the wine ethanol fuel to other fuels. If this is done, the boundaries and allocation methods of the compared studies must be the same as for the wine ethanol fuel study. If the boundaries and allocation differ for different studies, these studies can not be considered comparable. It was shown that one of the largest singel environmental impacts of the life-cycle of wine ethanol fuel was the transport of the raw ethanol from Italy to Sweden. Chosing a different transport, for example a boat with cleaning devices for exhaust gas, would strongly affect the result. The high fuel consumption during the grape cultivation is also an important contributing factor for the result, and it must be regognized that grape cultivation probably is carried out in different ways in different parts of the world. There are other fuels where wine ethanol is a component, but ETAMAX D is the only pure ethanol fuel in Sweden today (1998). The ethanol in ETAMAX D does not necessarily have to come from wine, though this is the origin of ethanol used in bus fuel at present time.
	About Data	All production data have been obtained from technicians or sales managers of the different companies involved. In order to receive reliable data for wine ethanol, several distilleries, wine producers and grape cultivators were visited on the sites of production. Data for the grape cultivation have the highest uncertainties due to the fact that weather conditions and cultivation areas (flat or hilly cultivation) will strongly affect the fertiliser and fuel use. The greater part of all data originates from report to authoroties and environmental reports. An exception is the production of Beraid 3540. During the production of this additive, measurements were carried out on site. Discussions with technicians at Akzo Nobel have been carried out to a greater extent than for other companies involved. Data for electricity, where the electricity have been bought from the state net, is based on the electricity profile for the country in question (profile from 1995). The energy raw materials for electricity production are traced back to the extraction in the same way as for fuels which are not used for electricity production. For petrochemical raw materials used in Sweden, the raw material extraction is assumed to take place in Norway. For petrochemical raw materials used in other parts of the world, a world average is used. Data for transportation are average data for long distance transports in Sweden, applicalble for trucks produced 1995 or later. Since most raw materials are bulk chemicals, quite new catalyst equipped vehicles and empty returns are assumed. For transportations in Italy, older trucks without catalysts are assumed. For the boat transport of raw ethanol from Italy to Sweden, the data were collected from the particular shipping company. The electricity consumption for the system is not displayed in the activity/flow meta data, since electricity is produced within the system and therefore does not represent one of the outflows/inflows from/to the system. However, the consumption of electricity has been calculated to be 3.36 MJ/kg ETAMAX D, from which 0.96 MJ derive from hydro power and 0.76 MJ derive from nuclear power.
	Notes	The report on the study of wine ethanol fuel is the result of a Master of Science thesis carried out in co-operation with Akzo Nobel Surface Chemistry and Chalmers University of Technology. Olle Ramnäs, Chalmers University of Technology, who is mentioned as reviewer of the study, was the examiner of the final thesis. The final thesis report comprises a cradle to grave study, not a cradle to gate study, which is the type of study described here. The purpose of excluding the combustion of the fuel here, is to leave the user of the data the possibility to use any emission data from ethanol buses. The report also displays a comparison of wine ethanol fuel to diesel, natural gas and ethanol from wheat and wood.

SPINE LCI dataset: Production of wood

	Administrative	
	Finished	Y
	Date Completed	02-12-31
	Copyright	
	Availability	Public

Technical System	
Name	Production of wood
Functional Unit	1 kg wood.
Functional Unit Explanation	1 kg wood for package use in Sweden
Process Type	Gate to gate
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	This activity describes a process step included in the system ''Production of plywood boxes'', also available in the SPINE@CPM database. Plywood boxes are used to pack the coated and non-coated roller bearings from SKF, Göteborg, during the transportation to customers. The plywood boxes are manufactured by Nefab Emballage AB in Alfta, Sweden. The plywood box consist of plywood, steel strips, steel nails and wooden splits. Wooden splits are attached to the bottom of the box to enable forklift handling. Nefab Emballage AB buys the wooden splits from a local sawmill, Alfta Pall AB, in Alfta, Sweden. This dataset describes the production of wood for the wooden splits. The database in LCAiT - production of 1 kg of wood for package use in Sweden - is used [Tillman et al., Chalmers Industriteknik, Gothenburg, Sweden, 1992. Packaging and the Environment, Tillman et al., Chalmers Industriteknik, Gothenburg, Sweden, 1992.]. The data includes transports and extraction of raw material.

System Boundaries	
Nature Boundary	Emissions to air and water are included.
Time Boundary	The analysis is performed during autumn 1992.
Geographical Boundary	Sweden
Other Boundaries	Emissions fom combustion of fuels and from the production of electricity are already included in the results from this file. The electricity is accounted for as ''Electricity, Swedish average'' The dataset is including transports and extraction of raw materials. Note that all the energy carriers (presented in MJ in the inventory profile) are ''internal parameters'' i.e. they are already presented as primary resources in gram.
Allocations	Allocations have been made according to weight.
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	The data set is obtained from an earlier LCA study by Packforsk Consulting AB. The analysis is based on information from Packaging and the Environment, Tillman et al., Chalmers Industriteknik, Gothenburg, Sweden, 1992. The analysis is performed by Tomas Ekvall, Elin Eriksson , Mikael Kullman and Göran Svensson, Chalmers Industriteknik, Gothenburg, Sweden, autumn 1992.
Literature Reference	* The analysis is based on information from Packaging and the Environment, Tillman et al., Chalmers Industriteknik, Gothenburg, Sweden, 1992. The analysis is performed by Tomas Ekvall, Elin Eriksson , Mikael Kullman and Göran Svensson, Chalmers Industriteknik, Gothenburg, Sweden, autumn 1992. * Simplified life cycle assessment for the comparison

	of two packaging alternatives for medium-sized roller bearings; April 2001; Pär Weström at Packforsk Consulting AB; Report no. C00 528.
Notes	For 1 kg of hot mix, 0,24 g of Wetfix I are required according to the maximum dosage. For the amount of hot mix required for 1km of road, refer to the ''Functional unit explenation'' in the technical system.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Uranium ore	2.38e-003			g	Ground	
	Input	Refined resource	Crude oil	35.373			g	Ground	
	Input	Refined resource	Diesel	0.973			MJ	Technosphere	
Notes: The energy carrier was called Electricity, Swedish average in LCAiT 3.	Input	Refined resource	Electricity	0.743			MJ	Technosphere	
	Input	Refined resource	Forest land	7.574			m2 year	Ground	
	Input	Refined resource	Hard coal	1.099			g	Ground	
Notes: As MJ electricity.	Input	Refined resource	Hydro power	0.349			MJ	Ground	
	Input	Refined resource	Natural gas	1.294			g	Ground	
	Input	Refined resource	Oil	0.377			MJ	Technosphere	
	Input	Refined resource	Peat	0.156			g	Ground	
	Input	Refined resource	Renewable fuel	2.286			MJ	Technosphere	
	Output	Emission	Ashes	1.883			g	Air	
	Output	Emission	CO	2.592			g	Air	
	Output	Emission	CO2	116.000			g	Air	
	Output	Emission	COD	1.58e-003			g	Water	
	Output	Emission	Hydrocarbons	0.501			g	Air	
	Output	Emission	Methane	2.73e-002			g	Air	
	Output	Emission	N total	2.58e-004			g	Water	
	Output	Emission	N2O	4.69e-003			g	Air	
	Output	Emission	NOx	1.715			g	Air	
	Output	Emission	Oil	5.40e-004			g	Water	
	Output	Emission	Particles	0.139			g	Air	
	Output	Emission	Phenol	7.69e-006			g	Air	
	Output	Emission	SO2	0.379			g	Air	
	Output	Product	Wood	1			kg	Technosphere	
	Output	Residue	Biomass	120.831			g	Ground	
	Output	Residue	Highly radioactive	1.00e-003			cm3	Ground	
	Output	Residue	Low radioactive	1.14e-002			cm3	Ground	
	Output	Residue	Medium radioactive	1.14e-002			cm3	Ground	

About Inventory

Publication	Master thesis: LCA based solution selection; Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ------------ Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. Both types of bearings are packed in a plywood box. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.

Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for production of wood for package use in Sweden.
About Data	The analysis is based on information from Packaging and the Environment, Tillman et al., Chalmers Industriteknik, Gothenburg, Sweden, 1992. The analysis is performed by Tomas Ekvall, Elin Eriksson , Mikael Kullman and Göran Svensson, Chalmers Industriteknik, Gothenburg, Sweden, autumn 1992.
Notes	

SPINE LCI dataset: Production of wood Adhesive PVAC 3316

Administrative	
Finished	Y
Date Completed	2000-02-24
Copyright	Casco Products
Availability	Public

Technical System	
Name	Production of wood Adhesive PVAC 3316
Functional Unit	1 kg dry wood adhesive PVAC 3316
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg dry wood adhesive PVAC 3316 (Cascol 3316). The adhesive is delivered with 47% dry content. As an average 57 g of package material per kg dry adhesive is delivered.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Wood Adhesive PVAC 3316 (Cascol 3316) is a formulation of polyvinylacetate, filler, solvent and additives. The adhesive is produced by Casco Products, Sweden. It is delivered in disposable containers (polyethylene/steel), polyethylene pails or polypropylene drums. The production of the main raw materials is described below: 1. Natural gas production: The study includes winning, delivery to shore and storage. Natural gas is used in the production of raw materials for polyvinylacetate dispersion and solvent. 2. Crude oil production. The study includes winning, delivery to shore ans storage. Crude oil is used in the production ofraw materials for polyvinylacetate dispersion and solvent. 3. There are various processes to produce acetylene and acetic acid, the main raw materials for vinylacetate production. It is not known which processes that are used in this case. 4. Vinylacetate is polymerised to polyvinylacetate with the help of radical forming catalysts. The temperature is often 70-80°C. In this case an emulsion polymerisation in the presence of wetting agent, protective colloides and catalyst is made. 5. Limestone is extracted from the earth, grind and sieved according to the specification for the filler. Extraction an transports are accounted for. 6. Detailes of the process used for the solvent is not known. 7. The PVAc dispersion, filler , solvent and other additives are mixed together at Casco Products' Decorative Coatings' factory in Kristinehamn, Sweden.

	Overall information: Transports are included in the system.

System Boundaries

Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally , in densly populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1997, beeing yearly averages where possible. No great changes after that are estimated. The data from Decorative Coatings factory in Kristinehamn are from 1998.
Geographical Boundary	The production of the raw materials is made on different sites in Europe. TheMixing of the raw materials is made at Decorative Coatings' factory, Kristinehamn, Sweden.
Other Boundaries	An average of the packages for the product is included in this study. The transportation to the users, use and final desposal of theadhesive is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included.
Allocations	Emissions and waste at the Decoraitve Coatings facory in Kristinehamn where the final mixing of teh raw materials is done are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from environmental Report 1998 and Production Statistics 1998. Allocations were made on mass basis.
Literature Reference	* The analysis is based on information from Packaging and the Environment, Tillman et al., Chalmers Industriteknik, Gothenburg, Sweden, 1992. The analysis is performed by Tomas Ekvall, Elin Eriksson , Mikael Kullman and Göran Svensson, Chalmers Industriteknik, Gothenburg, Sweden, autumn 1992. * Simplified life cycle assessment for the comparison of two packaging alternatives for medium-sized roller bearings; April 2001; Pär Weström at Packforsk Consulting AB; Report no. C00 528.
Notes	For 1 kg of hot mix, 0,24 g of Wetfix I are required according to the maximum dosage. For the amount of hot mix required for 1km of road, refer to the ''Functional unit explenation'' in the technical system.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Bauxite	0.4			g	Ground	
	Input	Natural resource	Coal	5.94			MJ	Ground	
	Input	Natural resource	Copper ore	0.8			g	Ground	
	Input	Natural resource	Crude oil	53.49			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	1.16			MJ	Ground	
	Input	Natural resource	Iron ore	46.1			g	Ground	
	Input	Natural resource	Limestone	46.2			g	Ground	
	Input	Natural resource	Minerals	66.5			g	Ground	

	Input	Natural resource	Natural gas	44.54			MJ	Ground	
Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	3.68			MJ	Ground	
	Input	Natural resource	Other fuel	1.6			MJ	Ground	
	Input	Natural resource	Uranium ore	0.45			g	Ground	
	Input	Natural resource	Wood	0.49			MJ	Ground	
	Output	Emission	Biocides	0.09			kg	Air	
	Output	Emission	CO	6.4			g	Air	
	Output	Emission	CO2	2807			g	Air	
	Output	Emission	COD	11.2			g	Water	
	Output	Emission	Dissolved solids	0.21			g	Water	
	Output	Emission	Dust	1.6			g	Air	
	Output	Emission	HCl	0.04			g	Air	
	Output	Emission	Hydrocarbons	3.6			g	Air	
	Output	Emission	Hydrogen	0.09			MJ	Air	
	Output	Emission	Ionics	6.3			g	Air	
	Output	Emission	Metals	0.29			g	Air	
	Output	Emission	Methane	8.7			g	Air	
	Output	Emission	N total	0.013			g	Water	
	Output	Emission	NOx	17			g	Air	
	Output	Emission	PAH	0.17			g	Air	
	Output	Emission	Phosphate as P2O5	0.1			g	Air	
	Output	Emission	SOx	13.5			g	Air	
	Output	Emission	Suspended solids	0.6			g	Water	
	Output	Emission	Total organic carbon	5.5			g	Water	
	Output	Emission	VOC	11.4			g	Air	
	Output	Product	PVAc 3316	1			kg	Technosphere	
	Output	Residue	Mineral waste	12.6			g	Technosphere	
	Output	Residue	Mixed industrial waste	3.6			g	Technosphere	
	Output	Residue	Non hazardous waste	161.3			g	Technosphere	
	Output	Residue	Slags and ash	4.4			g	Technosphere	
	Output	Residue	Sludge (Dry matter)	1			g	Technosphere	

About Inventory

Publication	-- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden Published in SPINE@CPM: 7 August 2001 --
Intended User	Users of PVAc wood adhesive Ca
General Purpose	
Detailed Purpose	To provide LCI data to producers of carpentry, furniture and other wood products where PVAc wood adhesives are used.
Commissioner	- Casco Products Box 11538, S-10061 Stockholm, Sweden .
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	Wood adhesive Cascol 3316 is suitable forveneering and jointing in hot-and cold press. It should always be used for indoor purposes. Data describing two other PVAC wood adhesives produced by Casco Products is available in the database; PVAC 3318 and PVAC 3326. More information about adhesives can be given

	by Casco Products, phone no 46 8 743 4000.
About Data	For the final production of wood adhesive 3316 all data originates from Decorative Coatings factory in Kristinehamn. For raw materials and auxilary materials suppliers have participated on terms that their data will be treated confidentially. For the production of polyvinylacetate cradle to gate data wer provided, for vinylacetate monomer , filler, solvent and additives cradle to gate data. For fuel data from APME Ecoprofiles are used.. Raw materials used are mentioned under ''Object of study/Functions) Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1995 from ''Annual Energy Review 1997'' (European comission) Building of the power plant is not included.
Notes	

SPINE LCI dataset: Production of wood Adhesive PVAC 3318

Administrative	
Finished	Y
Date Completed	2000-02-14
Copyright	Casco Products
Availability	Public

Technical System	
Name	Production of wood Adhesive PVAC 3318
Functional Unit	1 kg dry wood adhesive PVAC 3318
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg dry wood adhesive PVAC 3318 (Cascol 3318). The adhesiver is delivered with 47% dry content. As an average 97 g of package material per kg dry adhesive is delivered.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Wood Adhesive PVAC 3318 (Cascol 3318) is a formulation of polyvinylacetate, fillers, solvent and additives. The adhesive is produced by Casco Products, Sweden. It is delivered in disposable containers (polyethylene/steel), polyethylene pails or polypropylene drums. The production of the main raw materials is described below: 1. Natural gas production: The study includes winning, delivery to shore and storage. Natural gas is used in the production of raw materials for polyvinylacetate dispersion and solvent. 2. Crude oil production. The study includes winning, delivery to shore and storage. Crude oil is used in the production of raw materials for polyvinylacetate dispersion and solvent. 3. There are various processes to produce acetylene and acetic acid, the main raw materials for vinylacetate production. It is not known which processes that are used in this case. 4. Vinylacetate is polymerised to polyvinylacetate with the help of radical forming catalysts. The temperature is often 70-80°C. In this case an emulsion polymerisation in the presence of wetting agent, protective colloides and catalyst is made. 5. Limestone is extracted from the earth grind and sieved according to the specifications of the filler. Extraction an transports are accounted for. 6. Detailes of the process used for the solvent is not known.

	7. The PVAc dispersion, filler , solvent and other additives are mixed together at Casco Products Decorative Coatings' factory in Kristinehamn, Sweden. Overall information: Transports are included in the system.

System Boundaries

Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally , in densly populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1997, beeing yearly averages where possible. No great changes after that are estimated. The data from Decorative Coatings factory in Kristinehamn are from 1998.
Geographical Boundary	The production of the raw materials is made on different sites in Europe. The mixing of the raw materials is made at Decorative Coatings' factory, Kristinehamn, Sweden.
Other Boundaries	An average of the packages for the product is included in this study. The transportation to the users, use and final desposal of theadhesive is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included.
Allocations	Emissions and waste at the Decoraitve Coatings facory in Kristinehamn where the final mixing of teh raw materials is done are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from Environmental report 1998 and ProduktionsStatistics 1998. Allocations were made on mass basis.
Literature Reference	
Notes	For 1 kg of hot mix, 0,24 g of Wetfix I are required according to the maximum dosage. For the amount of hot mix required for 1km of road, refer to the ''Functional unit explenation'' in the technical system.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Bauxite	0.3			g	Ground	
	Input	Natural resource	Coal	6.24			MJ	Ground	
	Input	Natural resource	Copper ore	0.9			g	Ground	
	Input	Natural resource	Crude oil	51.34			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	1.39			MJ	Ground	
	Input	Natural resource	Iron ore	48.2			g	Ground	
	Input	Natural resource	Limestone	46.6			g	Ground	
	Input	Natural resource	Minerals	66.5			g	Ground	
	Input	Natural resource	Natural gas	44.81			MJ	Ground	

Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	4.34			MJ	Ground	
	Input	Natural resource	Other fuel	1.99			MJ	Ground	
	Input	Natural resource	Uranium ore	0.53			g	Ground	
	Input	Natural resource	Wood	0.52			MJ	Ground	
	Output	Emission	Biocides	0.09			kg	Air	
	Output	Emission	CO	6.5			g	Air	
	Output	Emission	CO2	2989			g	Air	
	Output	Emission	COD	10.8			g	Water	
	Output	Emission	Dissolved solids	0.23			g	Water	
	Output	Emission	Dust	1.8			g	Air	
	Output	Emission	HCl	0.04			g	Air	
	Output	Emission	Hydrocarbons	4.8			g	Air	
	Output	Emission	Hydrogen	0.09			MJ	Air	
	Output	Emission	Ionics	6.3			g	Air	
	Output	Emission	Metals	0.3			g	Air	
	Output	Emission	Methane	8.8			g	Air	
	Output	Emission	N total	0.015			g	Water	
	Output	Emission	NOx	17.7			g	Air	
	Output	Emission	PAH	0.15			g	Air	
	Output	Emission	Phosphate as P2O5	0.09			g	Air	
	Output	Emission	SOx	14.3			g	Air	
	Output	Emission	Suspended solids	0.6			g	Water	
	Output	Emission	Total organic carbon	5.4			g	Water	
	Output	Emission	VOC	11.3			g	Air	
	Output	Product	PVAc 3318	1			kg	Technosphere	
	Output	Residue	Mineral waste	13			g	Technosphere	
	Output	Residue	Mixed industrial waste	3.8			g	Technosphere	
	Output	Residue	Non hazardous waste	155.4			g	Technosphere	
	Output	Residue	Slags and ash	4.6			g	Technosphere	
	Output	Residue	Sludge (Dry matter)	1			g	Technosphere	

About Inventory

Publication	-- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden Published in SPINE@CPM: 7 August 2001 --
Intended User	Users of PVAc wood adhesive Ca
General Purpose	
Detailed Purpose	To provide LCI data to producers of carpentry, furniture and other wood products where PVAc wood adhesives is used.
Commissioner	- Casco Products Box 11538, S-10061 Stockholm, Sweden .
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	Wood adhesive Cascol 3318 is suitable for jointing in hot-and high frequency press. It should always be used for indoor purposes. Data describing two other PVAC wood adhesives produced by Casco Products is available in the database; PVAC 3316 and PVAC 3326. More information about adhesives cn be given by Casco Products 46 8 743 4000.

About Data	For the final production of wood adhesive 3318 all data originates from Decorative Coatings factory in Kristinehamn. For raw materials and auxilary materials suppliers have participated on terms that their data will be treated confidentially. For the production of polyvinylacetate cradle to gate data wer provided, for vinylacetate monomer , filler, solvent and additives cradle to gate data. For fuel data from APME Ecoprofiles are used. Raw materials used are mentioned under ''Object of study/Functions) Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1995 from ''Annual Energy Review 1997'' (European comission) Building of the power plant is not included.
Notes	

SPINE LCI dataset: Production of wood Adhesive PVAC 3326

Administrative	
Finished	Y
Date Completed	2000-02-14
Copyright	Casco Products
Availability	Public

Technical System	
Name	Production of wood Adhesive PVAC 3326
Functional Unit	1 kg dry wood adhesive PVAC 3326
Functional Unit Explanation	All emissions, use of resourses and energy consumption is based on 1 kg dry adhesive wood adhesive PVAC 3326 (Cascol 3326). The adhesiver is delivered with 47% dry content. As an average 109 g of package material per kg dry adhesive is delivered.
Process Type	Cradle to gate
Site	Europe
Sector	
Owner	Europe
Technical system description	Wood Adhesive PVAC 3326 (Cascol 3326) is a formulation of polyvinylacetate, fillers, solvent and additives. The adhesive is produced by Casco Products, Sweden. It is delivered in disposable containers (polyethylene/steel), polyethylene pails or polypropylene drums. The production of the main raw materials is described below: 1. Natural gas production: The study includes winning, delivery to store and storage. Natural gas is used in the production of raw materials for polyvinylacetate dispersion and solvent. 2. Crude oil production. The study includes winning, delivery to store ans storage. Crude oil is used in the production ofraw materials for polyvinylacetate dispersion and solvent. 3. There are various processes to produce acetylene and acetic acid, the main raw materials for vinylacetate production. It is not known which processes that are used in this case. 4. Vinylacetate is polymerised to polyvinylacetate with the help of radical forming catalysts. The temperature is often 70-80°C. In this case an emulsion polymerisation in the presence of wetting agent, protective colloides and catalyst is made. 5. Limestone is extracted from the earth, grind and sieved according to the filler specifications.. Extraction an transports are accounted for. 6. Detailes of the process used for the solvent is not known.

	7. The PVAc dispersion, filler , solvent and other additives are mixed together in Casco Products Decorative Coatings' factory, Kristinehamn, Sweden. Overall information: Transports are included in the system.

System Boundaries

Nature Boundary	All emissions are considered equivalent, independently of where they take place (locally, regionally, globally , in densly populated areas or rural areas) The emissions presented were chosen as relevant for the product type. Most of the used data are measured, some estimated.
Time Boundary	Most of the process data for the raw materials are valid for 1997, beeing yearly averages where possible. No great changes after that are estimated. The data from Decorative Coatings factory in Kristinehamn are from 1998.
Geographical Boundary	The production of the raw materials is made on different sites in Europe. The mixing of the raw mateials is made at Decorative Coatings' factory, Kristinehamn, Sweden.
Other Boundaries	An average of the packages for the product is included in this study. The transportation to the users, use and final desposal of theadhesive is not included. The environmental effects associated with the manufacture of capital equipement and with energy and fuel requirements for plant and buildings conditioning (heat, air, etc) were not included, neither were those associated with personnel requirements. Water consumption was not included.
Allocations	Emissions and waste at the Decoraitve Coatings facory in Kristinehamn where the final mixing of the raw materials is done are allocated on a mass basis among the products that may cause them. Energy required to heat storage buildings, etc is allocated on a mass basis among the products that are stored there.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	Accounted as an inventory profile. Data from suppliers and litterature were used. For emission and waste data in our own factory data were taken from Environmental Report 1998 and Production Statistics 1998. Allocations were made on mass basis.
Literature Reference	
Notes	For 1 kg of hot mix, 0,24 g of Wetfix I are required according to the maximum dosage. For the amount of hot mix required for 1km of road, refer to the ''Functional unit explenation'' in the technical system.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Bauxite	0.6			g	Ground	
	Input	Natural resource	Coal	6.78			MJ	Ground	
	Input	Natural resource	Copper ore	0.9			g	Ground	
	Input	Natural resource	Crude oil	53.86			MJ	Ground	
Represents: Energy needed to produce electricity from hydro power Method: Electricity from hydro power is assumed to be produced with 80% efficiency	Input	Natural resource	Hydro energy	1.36			MJ	Ground	
	Input	Natural resource	Iron ore	123.6			g	Ground	
	Input	Natural resource	Limestone	49.9			g	Ground	
	Input	Natural resource	Minerals	66.5			g	Ground	
	Input	Natural resource	Natural gas	45.12			MJ	Ground	

Represents: Energy content in uranium needed to produce electricity in a nuclear power plant Method: Electricity from nuclear power is assumed to be produced with 35 % efficiency	Input	Natural resource	Nuclear energy	4.23			MJ	Ground	
	Input	Natural resource	Other fuel	1.87			MJ	Ground	
	Input	Natural resource	Uranium ore	0.52			g	Ground	
	Input	Natural resource	Wood	0.75			MJ	Ground	
	Output	Emission	Biocides	0.09			kg	Air	
	Output	Emission	CO	6.5			g	Air	
	Output	Emission	CO2	2931			g	Air	
	Output	Emission	COD	11.3			g	Water	
	Output	Emission	Dissolved solids	0.22			g	Water	
	Output	Emission	Dust	1.7			g	Air	
	Output	Emission	HCl	0.04			g	Air	
	Output	Emission	Hydrocarbons	4.6			g	Air	
	Output	Emission	Hydrogen	0.09			MJ	Air	
	Output	Emission	Ionics	6.3			g	Air	
	Output	Emission	Metals	0.3			g	Air	
	Output	Emission	Methane	8.9			g	Air	
	Output	Emission	N total	0.015			g	Water	
	Output	Emission	NOx	17.8			g	Air	
	Output	Emission	PAH	0.16			g	Air	
	Output	Emission	Phosphate as P2O5	0.1			g	Air	
	Output	Emission	SOx	14.3			g	Air	
	Output	Emission	Suspended solids	0.6			g	Water	
	Output	Emission	Total organic carbon	5.5			g	Water	
	Output	Emission	VOC	11.4			g	Air	
	Output	Product	PVAc 3326	1			kg	Technosphere	
	Output	Residue	Mineral waste	13			g	Technosphere	
	Output	Residue	Mixed industrial waste	3.9			g	Technosphere	
	Output	Residue	Non hazardous waste	224.4			g	Technosphere	
	Output	Residue	Slags and ash	4.6			g	Technosphere	
	Output	Residue	Sludge (Dry matter)	1			g	Technosphere	

About Inventory

Publication	-- Data documented by: Birgit Nilsson, Casco Products, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden Published in SPINE@CPM: 7 August 2001 --
Intended User	Users of PVAc wood adhesive Ca
General Purpose	
Detailed Purpose	To provide LCI data to producers of carpentry, furniture and other wood products where PVAc wood adhesives is used.
Commissioner	- Casco Products Box 11538, S-10061 Stockholm, Sweden .
Practitioner	Nilsson, Birgit - Casco Products Box 11538, S-10061 Stockholm, Sweden .
Reviewer	
Applicability	Wood adhesive Cascol 3326 is an allround product suitable for many different kind of wood products. It should always be used for indoor purposes. Data describing two other PVAC wood adhesives produced by Casco Products is available in the database; PVAC 3318 and PVAC 3316. More information about adhesives can be given by Casco Products 46 8 742 4000.

About Data	For the final production of wood adhesive 3326 all data originates from Decorative Coatings factory in Kristinehamn. For raw materials and auxilary materials suppliers have participated provided that their data will be treated confidentially. For the production of polyvinylacetate cradle to gate data wer provided, for vinylacetate monomer , filler, solvent and additives cradle to gate data. For fuel data from APME Ecoprofiles are used. Raw materials used are mentioned under ''Object of study/Functions) Overall information: Transports are included in the system. The fuels for the transports are traced back to the extraction of petrochemical raw materials and the extraction of bio fuels. The electricity data are based on the electricity profiles for each country . For coal, lignite and natural gas data from ETH,Switzerland have been used. For other kinds of energy data from Vattenfall, Sweden have been used. These are combined into energy mixes for different countries according to statistics of 1995 from ''Annual Energy Review 1997'' (European comission) Building of the power plant is not included.
Notes	

SPINE LCI dataset: Propane fired combination plant for heat and power production

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Propane fired combination plant for heat and power production
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a propane fired plant for heat and power production in Sweden. The plant is combined with one gas turbine and one steam turbine with a common generator and a waste heat boiler. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): 1 682 Total electric power output (MW): 30 Total thermal output (MW): 32 Annual total fuel use (MWh): 104 716 Normal annual production of heat (MWh): 44 337 Normal annual production of electricity (MWh): 41 190 Degree of efficiency (%): 82 PROCESS DESCRIPTION: The unit consists of one propane fired gas tubine and one steam turbine with a common generator and a waste heat boiler for steam production. The maximum thermal output is 32 MW. The heat is delivered to a district heating net. INCLUDED OPERATIONS: The process study consists of the following operations: - The feeding of the propane into the combustion process. - The combustion process.

	- The production of heat. - The internal consumption of electricity. - The NOx control system. NOx CONTROL: The combustion chamber is equiped with a low-NOx-burner to minimize the emissions of NOx. OTHER FLUE GAS CLEANING SYSTEMS: Propane leaves no sulphur oxides or dust as emissions and therefore no cleaning of the flue gas is done.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. According to experience the emission of HC are close to zero (not measurable) when propane is fired.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION: This inventory has been conducted on a propane fired plant for heat production in Sweden, with swedish regulations, applicable during 1996. The collected data should only be used for swedidh conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operatios have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant, the district heating net or the electricity supply system. - The cradle to gate of the internal electricity consumption. - The production of propane. - The transportation of propane to the plant. EXCLUDED FLOWS - The chemicals used for feed water treatment. - The water consumption in the process.
Allocations	PRINCIPLE APPLIED: In a combined power and heating plant two products of economic value are produced. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat and power respectively. For the use of resources and emission that are specific for the electric power production are allocated to that production. Equivalent to this the use of resources and emissions specific for heat production are allocated to that production. Note: When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	All data reported are related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amount of an input (fuel, electericity) to or an output (emission, product) from the energy plant. The inputs and outputs are the related to the functional unit by deviding the total yearly amount with the yearly amount of produced heat and multiplying with the fraction of the total production that are associated with the heat production. For some flows specific information is given, see each flow.
Literature Reference	Data are in general recieved from ''Miljörapport 1996, Karlskoga Kraftvärmeverk AB''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. Data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Method: Not known.	Input	Refined resource	Electricity	0.00118			kWh	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Propane	97.1			g	Technosphere	
Data type: Monitored data, continuous Method: This emission is measured continously. Literature: Miljörapport 1996, Karlskoga Kraftvärmeverk AB	Output	Emission	CO	0.0957			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with propane, according to NUTEK. The standard value for propane is 65 g/MJ fuel.	Output	Emission	CO2	253			g	Air	
Notes: No dust is emitted from the combustion of propane.	Output	Emission	Dust	0			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continously. Literature: MIljörapport 1996, Karlskoga Kraftvärmeverk AB	Output	Emission	NOx	0.216			g	Air	
Notes: Prpsane contains no sulphur.	Output	Emission	SO2	0			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended users of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose was to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory has been conducted on a propane fired plant for heat production in Sweden, with swedish regulations, applicable during 1996. This data is assumed to be valid until new national or local regulaitons are enforced in Sweden. The collected data should only be used on plants producing heat in Sweden and for swedish conditions. When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own intrerest or as a consequence of an internal control program.
Notes	

SPINE LCI dataset: Propane fired plant for heat production - Large plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Propane fired plant for heat production - Large plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a propane fired plant for heat production in Sweden. The plant consists of a hot water boiler unit. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): 5586 Total thermal output (MW): 53 Annual total fuel use (MWh): 167 645 Normal annual production of heat (GWh): 163 Degree of efficiency (%): 97 PROCESS DESCRIPTION: The propane is incinerated in a hot water boiler unit. The maximum thermal output is 53 MW. Hot water is produced and transmitted into heat for the district heating net. Oil is used as reserve fuel, but is not included in this system. INCLUDED OPERATIONS: The process study consists of the following operations: -The feeding of the propane into the combustion process. -The combustion process. -The production of heat. -The internal consumption of electricity. - The NOx control system. NOx CONTROL: The burner is equiped with an low-NOx-burner to minimize the emissions of NOx.. OTHER FLUE GAS CLEANING SYSTEMS: Propane leaves no sulphur oxides or dust as emissions and therefore no cleaning of the flue gas is done.

System Boundaries	
Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. According to experience the emission of HC are close to zero (not measurable) when propane is fired.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data from 1996. The data consist of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.

Geographical Boundary	GEOGRAPHICAL EXTENSION: This inventory has been conducted on a propane fired plant for heat production in Sweden, with swedish regulations, applicable during 1996. The collected data should only be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: -The use of reserve fuel (oil). -The distribution of district heat from the plant to the consumers. -Building of the plant, the district heating net or the electricity supply system. -The cradle to gate of the internal electricity consumption. -The production of propane. -The transportation of propane to the plant. EXCLUDED FLOWS -The chemicals used for feed water treatment. -The water consumption in the processes.
Allocations	PRINCIPLE APPLIED: In a heating plant one product of economic value is produced, heat. For operation and maintenance of the plant the use of resources and emissions are associated to the net production of heat. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	All data reported are related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amount of an input (fuel, electricity) to or an output (emission, product) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the total yearly amount with the yearly amount of produced heat. For some flows specific information is given, see each flow.
Literature Reference	Data are in general recieved from ''Miljörapport 1996, Borås Energi AB''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: Not known.	Input	Refined resource	Electricity	0.0000071			kWh	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Propane	80.1			g	Technosphere	
Data type: Single sample Method: This emission is measured at the yearly periodical inspection. The yearly amount of this emission is then estimated from this single sample. Literature: Miljörapport 1996, Borås Energi AB.	Output	Emission	CO	0.0611			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with propane, according to NUTEK. The standard value for propane is 65 g/MJ fuel.	Output	Emission	CO2	253			g	Air	
Notes: No dust is emitted from the combustion of propane.	Output	Emission	Dust	0			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continously. Literature: Miljörapport 1996, Borås Energi AB	Output	Emission	NOx	0.205			g	Air	
Notes: Propane contains no sulphur.	Output	Emission	SO2	0			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose was to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory has been conducted on a propane fired plant for heat production in Sweden, with swedish regulations, applicable during 1996. This data is assumed to be valid until new national or local regulations are enforced in Sweden. The collected data should only be used on plants producing heat in Sweden and for swedish conditions.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.
Notes	

SPINE LCI dataset: Propane fired plant for heat production - Small plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Propane fired plant for heat production - Small plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden

Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a propane fired plant for heat production in Sweden. The plant consists of three hot water boiler units. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): - Total thermal output (MW): 5+5+10 Annual total fuel use (MWh): 64 388 Normal annual production of heat (MWh): 59 646 Degree of thermal efficiency (%): 92,6 PROCESS DESCRIPTION: The plant consists of three hot water boiler units, two of 5 MWh thermal output and one of 10 MWh thermal output. The propane is incinerated in the boilers. Hot water is produced and transmitted into heat for the district heating net. Oil is used as reserve fuel, but is not included in this system. INCLUDED OPERATIONS: The process study consists of the following operations: - The feeding of the propane into the combustion process. - The combustion process. - The production of heat. - Internal consumption of electricity. NOx CONTROL: The boilers are not equiped with any NOx control system. OTHER FLUE GAS CLEANING SYSTEMS: Propane leaves no sulphur oxides or dust as emissions and therefore no cleaning of the flue gas is needed.

System Boundaries	
Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. According to experience the emission of HC are close to zero (not measurable) when propane is fired.
Time Boundary	APPLICABLE TIME OF SYSTEM/PRODUCT: This inventory was conducted using data from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION: This inventory has been conducted on a propane fired plant for heat production in Sweden, with swedish regulations, applicable during 1996. The collected data should be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations has been excluded from the system: - The use of reserve fuel (oil). - The distribution of district heat from the plant to the consumers. - Building of the plant, the district heating net and the electricity supply system. - The cradle to gate of the internal electricity consumption. - The production of propane. - The transport of propane to the plant. EXCLUDED FLOWS - The chemicals used for feed water treatment. - The water consumption in the process.
Allocations	PRINCIPLE APPLIED: In a heating plant one product of economic value are produced. For operation and maintenance of the plant the use of resources and emissions are associated to the net production of heat. DESCRIPTION:
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1996
Data Type	
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.

Method	All data reported are related to the functional unit 1 kWh heat produced and delivered. The data is originallty given as the total yearly amount of an input (fuel, electricity) to or an output (emission, product) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the total yearly amount with the yearly amount of produced heat. For some flows specific information is given, see each flow.
Literature Reference	Data is in general recieved from ''Miljörapport 1996, Ludvika Värme AB''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All data are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Method: Not known.	Input	Refined resource	Electricity	0.0182			kWh	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Propane	80.6			g	Technosphere	
Method: Not known.	Output	Emission	CO	0.611			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with propane, according to NUTEK. The standard value for propane is 65 g/MJ fuel.	Output	Emission	CO2	253			g	Air	
Notes: No dust is emitted from the combustion of propane.	Output	Emission	Dust	0			g	Air	
Method: This emission is based on measured data. The yearly mean value was used. Literature: Miljörapport 1996, Ludvika Värme AB	Output	Emission	NOx	0.222			g	Air	
Notes: Propane contains no sulphur.	Output	Emission	SO2	0			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data is t
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose was to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory has been conducted on a propane fired plant for heat production in Sweden, with swedish regulations, applicable during 1996. This data is assumed to be valid until new national or local regulations are enforced in Sweden. The collected data should only be used on plants producing heat in Sweden and for swedish conditions..
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.

Notes	

SPINE LCI dataset: Pulverized wood fired plant for heat and power production - Large plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Pulverized wood fired plant for heat and power production - Large plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a pulverized wood fired plant for heat and power production located in Sweden. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): 4960 Total electric power output (MW): 8,7 Total thermal output (MW): 68 Annual total fuel use (MWh): 340 000 Normal annual production of heat (MWh): 285 152 Normal annual production of electricity (MWh): 27 947 Degree of thermal efficiency (%): 92 PROCESS DESCRIPTION: The plant consists of two boiler units with a common steampipe line. The boilers are fired with pulverized wood and oil respectively. Only the boiler fired with wood is included in this study. The production from wood is 75 % of the total annual production from the plant. Only the part that can be referred to the pulverized wood incineration are presented above. ROFA (rotating overfired air). The ROFA system has been installed in order to improve the efficiency and to decrease the NOx emission. The dust is removed from the flue gas in an electrostatic precipitator. INCLUDED OPERATIONS: The process of study consists of the following operations: - The feeding of the pulverized wood into the combustion process. - The combustion process. - The removal of dust from the flue gas in the electrostatic precipitator. - The internal treatment of the residues from the combustion process. - The internal consumption of electricity. - The internal consumtion of chemicals for the feed water treatment. - The NOx control system NOx CONTROL: In the pulverized wood fired plant the overfire air is provided by the technique ROFA (rotating overfire air) which gives a better mixing of the air, leading to a better combustion. OTHER FLUE GAS CLEANING SYSTEMS: - For the removal of dust from the flue gas an electrostatic precipitator is used. In an electrostatic precipitator the dust particles are electrified and then separated from the flue

	gas stream by passing through an electric field with largest possible intensity. - Due to the low sulphur content in wood fules, no reduction of the sulphur content in the flue gas is needed.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported in a public environmental report. The emission of HC is not measured.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION: This inventory has been conducted on a pulverized wood fired plant for heat and power production in Sweden, with swedish regulations, applicable during 1996. The collected data should be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the internal electricity consumption. - The production of the pulverized wood fuel. - The transportation of the fuel to the plant. - The transportation of the residues from the combustion and cleaning processes to the landfill or back to the forest. - The processes at the landfill such as leaching, decomposition etc. - The spreading of the ashes in the forest. EXCLUDED FLOWS - The water consumption in the process.
Allocations	PRINCIPLE APPLIED: In a combined power and heating plant two products of economic value are produced, heat and electrical power. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat and power respectively. For the use of resources and the emissions that are specific for the electrical power production are allocated to that production. Equivalent to this the use of resources and the emissions specific for the heat production are allocated to that production. Note: When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	All data reported is related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amount of an input (fuel, chemical, electricity etc.) to or an output (emission, product) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the total yearly amount with the yearly amount of produced heat and multiplying with the fraction of the total production that are associated with the heat production. For some flows specific information is given, see each flow.
Literature Reference	Data is in general recieved from ''Miljörapport 1996, Jönköping Energi AB'' and personal communication.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: The consumed amount for the year.	Input	Refined resource	Bio fuel	220			g	Technosphere	

Method: Not known.	Input	Refined resource	Electricity	0.05			kWh	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Hydrochloric acid	0.0105			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	NaOH	0.00406			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Trisodium phosphate	0.000286			g	Technosphere	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with biofuels, according to NUTEK. The standard value for biofuels is 114 g/MJ fuel supplied.	Output	Emission	CO2	446			g	Air	
Method: Not known.	Output	Emission	Dust	0.00383			g	Air	
Method: Not known.	Output	Emission	NOx	0.247			g	Air	
Method: Not known.	Output	Emission	SO2	0.0391			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden. This data should only be used on plants producing heat in Sweden and for swedish conditions. When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.
Notes	Combined heat and power are used as base primarily during the winter half, when the need for heat and power are the largest.

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Pulverized wood fired plant for heat production - Small plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a pulverized wood fired plant for heat production. The plant is located in Sweden. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hour): 3012 Total thermal output (MW): 13,5 Annual total fuel use (MWh): 34 032 Normal annual production of heat (MWh): 33 083 Degree of thermal efficiency (%): 97,2 PROCESS DESCRIPTION: The plant consists of one boiler unit for the insineration of pulverized wood. The thermal output is 13,5 MW. The dust is removed from the flue gas using a multicyclone system INCLUDED OPERATIONS: The process studied consists of the following operations: - The feeding of the pulverized wood into the combustion process. - The combustion process. - The removal of dust from the flue gas in the multicyclone. - The internal consumption of electricity. NOx CONTROL: The boiler is not equiped with any NOx control system. OTHER FLUE GAS CLEANING SYSTEMS: For the removal of dust from the flue gas a multicyclone is used. Due to the low sulphur content in wood fules, no reduction of the sulphur content in the flue gas is needed.

System Boundaries	
Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. The emission of HC is not measured.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory has been conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION: This inventory has been conducted on a pulverized wood fired plant for heat production in Sweden, with swedish conditions, applicable during 1996. The collected data should be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the internal electricity consumption.

	- The production of the pulverized wood fuel. - The transportation of the fuel to the plant. - The transoprtation of the residues from the combustion and cleaning processes to the landfill or back to the forest. - The processes at the landfill such as leaching, decomposition etc. - The spreading of the ashes in the forest. EXCLUDED FLOWS - The water consumption in the process. - The chemicals for feed water treatment.
Allocations	PRINCIPLE APPLIED: In a heating plant one product of economic value are produced, heat. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	Flows to and from nature for a cradle to gate inventory of 1 kg of Wetfix I.
Method	All data reported is related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amount of an input (fuel, chemical, electricity etc.) to or an output (emission, product) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the total yearly amount of the produced heat. For some flows specific information is given, see each flow.
Literature Reference	Data is in general recieved from ''Miljörapport 1996, Göteborg Energi AB''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: The consumed amount for the year.	Input	Refined resource	Bio fuel	217			g	Technosphere	
Method: Not known.	Input	Refined resource	Electricity	0.05			kWh	Technosphere	
Method: Not known.	Output	Emission	CO	0.603			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with biofuels, according to NUTEK. The standard value for biofuels is 114 g/MJ fuel supplied	Output	Emission	CO2	422			g	Air	
Data type: Single sample Method: This emission is measured at the periodical inspection. The yearly amount of the emission is then estimated from this sample.	Output	Emission	Dust	0.15			g	Air	
Method: This emission was estimated from a short period of continuous measurement. The yearly amount of the emisiion is then estimated from this short period of measurement.	Output	Emission	NOx	0.653			g	Air	
Method: The yearly amount of this emission is estimated from the sulphur content of the fuel.	Output	Emission	SO2	0.0391			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	
Method: The formed amount for the year.	Output	Residue	Bottom ash	0.311			g	Technosphere	
Method: The formed amount for the year.	Output	Residue	Fly ash	0.213			g	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01.

	-- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden and for swedish conditions.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.
Notes	

SPINE LCI dataset: PVC

Administrative	
Finished	Y
Date Completed	1994
Copyright	
Availability	It's thought that the data presented here for the manufactur

Technical System	
Name	PVC
Functional Unit	1 kg of PVC
Functional Unit Explanation	
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	These are the different production steps. (1) The starting raw materials for PVC production are crude oil and/or natural gas and sodium chloride. (2) The hydrocarbon raw materials are converted to ethene and sodium chloride is electrolysed to produce chlorine. (3) The ethene and chlorine are reacted to produce 1,2-dichloroethane. This latter is then decomposed by heating in a high temperature furnace to obtain vinyl chloride.

	(4) A simple process of polymerisation is then obtained to get PVC.

System Boundaries

Nature Boundary	Air-, water- emissions emitted from our system Resource, input to our system
Time Boundary	
Geographical Boundary	Europe
Other Boundaries	
Allocations	Detailed roughly in the Eco-profile called : Report 5 : co-product allocation in chlorine plants APME April 1994
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	98/01/26
Data Type	Unspecified
Represents	These average values are based on three different types of the polymerisation of vinyl chloride monomer : - suspension polymerisation [14 plants in Europe] - emulsion polymerisation [5 plants in Europe] - bulk polymeriastion.
Method	Normal LCI method on the production of PVC (from cradle to the gate)
Literature Reference	Unspecified
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Bauxite	220			mg	Technosphere	Europe
	Input	Refined resource	Electricity	11.9			MJ	Technosphere	Europe
	Input	Refined resource	Heavy oil	22.02			MJ	Technosphere	Europe
	Input	Refined resource	Iron ore	400			mg	Technosphere	Europe
	Input	Refined resource	Limestone	1600			mg	Technosphere	Europe
	Input	Refined resource	NaCl	690000			mg	Technosphere	Europe
	Input	Refined resource	Natural sand	1200			mg	Technosphere	Europe
	Input	Refined resource	Other fuel	32.88			MJ	Technosphere	Europe
	Input	Refined resource	Water	1900000			mg	Technosphere	Europe
	Output	Emission	Acidification eq	110			mg	Water	Europe
	Output	Emission	BOD	80			mg	Water	Europe
	Output	Emission	Chloride	40000			mg	Water	Europe
	Output	Emission	Chlorinated organics	10			mg	Water	Europe
	Output	Emission	Chlorinated organics	720			mg	Air	Europe
	Output	Emission	Cl2	2			mg	Air	Europe
	Output	Emission	CO	2700			mg	Air	Europe
	Output	Emission	CO2	1944000			mg	Air	Europe
	Output	Emission	COD	1100			mg	Water	Europe
	Output	Emission	Dissolved organics	1000			mg	Water	Europe
	Output	Emission	Dissolved solids	500			mg	Water	Europe
	Output	Emission	HC	20000			mg	Air	Europe

	Output	Emission	HCl	230			mg	Air	Europe
	Output	Emission	Metals	200			mg	Water	Europe
	Output	Emission	Metals	3			mg	Air	Europe
	Output	Emission	Na+	2300			mg	Water	Europe
	Output	Emission	NOx	16000			mg	Air	Europe
Notes: Denoted as Other nitrogen in the report	Output	Emission	N-tot	3			mg	Water	Europe
	Output	Emission	Oil	50			mg	Water	Europe
	Output	Emission	Particles	3900			mg	Air	Europe
	Output	Emission	SOx	13000			mg	Air	Europe
	Output	Emission	Sulphates	4300			mg	Water	Europe
	Output	Emission	Susp solids	2400			mg	Water	Europe
	Output	Product	PVC	1			kg	Technosphere	Europe
	Output	Residue	Ashes	47000			mg	Technosphere	Europe
	Output	Residue	Industrial waste	1800			mg	Technosphere	Europe
	Output	Residue	Inert chemicals	14000			mg	Technosphere	Europe
	Output	Residue	Mineral waste	66000			mg	Technosphere	Europe
	Output	Residue	Regulated chemicals	1200			mg	Technosphere	Europe

About Inventory

Publication	Eco-profiles of the European polymer industry APME technical Report 6 : Polyvinyl chloride April 1994 -- Data documented by: Sophie Louis, Volvo Technical Development Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	APME's eco-profiles serve two
General Purpose	Production process Data averaged over all polymerisation processes APME [The Association of plastic Manufacturers in Europe] members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of PVC (all polymersiation processes included)
Commissioner	- APME, Avenue E. Van Nieuwenhuyse 4 Box 3 B-1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	Data averaged over all polymerisation processes
About Data	All operations up to the production of the polymer resin are covered. Any subsequent processes, such as compounding, which are carried out prior to conversion are excluded.
Notes	Ethylene production When the plant supplying with ethylene a specific site is known, then the specific data have been used. When, however the source of ethylene is not known or where the ethylene is drawn from the European pipeline, average pipeline have been used. Two sets of average data have been used for ethylene ; the results relevant to the European pipeline and the European average ; these data are extracted from a previous APME report called Eco-profile of the European Plastic Industry. Report 2 : Olefin Feedstock Sources. European Centre for Plastics in the Environment, Brussels. May 1993 Sources of sodium chloride Two methods for extracting sodium chloride exist : · brine pumping : water is pumped into a natural salt deposit when the salt dissolves to produce a saturated solution which may be pumped to the surface to be used ; · rock salt mining Here, data have been obtained for the mining of 415 000 tonnes of rock salt and the brine pumping of some 4,1 million tonnes of sodium chloride Chlorine production Chlorine is produced by the electrolysis of an aqueous solution of sodium chloride. Data have obtained from 14 chlorine plant which between them produce some 2,4 million tonnes of chlorine. Production of vinyl Chloride Monomer The production of VCM from ethylene and chlorine form a single plant and it is usually impossible to separate the operation of individual unit processes. Data have been obtained

	on the operation of this overall VCM unit from 10 plants which between them produce some 3,5 million of tonnes of VCM each year. PVC production Vinyl Chloride monomer is polymerised to PVC by three main methods : suspension polymerisation ; emulsion polymerisation and bulk polymerisation. Data havebeen obtained from a total of 14 polymerisation plants which annually produce some 2,2 million toones of PVC. Eight plant were using the suspension process and were producing some 1,6 million tonnes of PVC, five plants using em,ulsion polymerisation and producing some 400 000 tonnes of PVC and a single bulk polymerisation plant producing 165 000 tonnes of PVC.

SPINE LCI dataset: Rail transport - 10 trucks

Administrative	
Finished	Y
Date Completed	1993-01-01
Copyright	
Availability	Public

Technical System	
Name	Rail transport - 10 trucks
Functional Unit	tonkm, 80 %
Functional Unit Explanation	The energy use is calculated with reference to the transportation of 1 ton goods, 1 kilometre for an utilisation level of 80%.
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of an electrically driven engine with 10 trucks.

System Boundaries	
Nature Boundary	
Time Boundary	The aim was that the data should be representative for 1992.
Geographical Boundary	Sweden and other countries with a similar rail system.
Other Boundaries	Utilisation level with regard to weight: 80%. The energy use are only associated with the propulsion of the train *Not included in the system* Production and distribution of electricity Production and maintenance of the train and tracks
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1979-1984
Data Type	Unspecified

Represents	These average values are based on three different types of the polymerisation of vinyl chloride monomer : - suspension polymerisation [14 plants in Europe] - emulsion polymerisation [5 plants in Europe] - bulk polymeriastion.
Method	The electricity use of 10 trucks with an average load factor of 80 % can be read in figure 2.3, page 11, Backman et al. Figure 2.3 shows the electricity use as a function of load (25 -100% of total load capacity). The energy use for propulsion are measured at the primary side of the converter station (50 Hz, 3-phase, 6.3 kV). The energy use to reverse the points are included as an average addition of 6 % to the energy use. The background for figure 2.3 can be found in Backman et al (2). It is however not stated in Backman et al (2) how the background material was retrieved.
Literature Reference	1. Backman, H., and Cordi, I. \`Energieffektivitet i framtidens godstransporter\` Transportforskningsdelegationen 1984:1 2. Cordi, I et al, \`Energieffektiviteten för person- och godstransporter i Sverige. En jämförande analys. Appendix.\` TFD-rapport 1979:2, Transportforskningsdelegationen, 1979
Notes	National values for environmental loadings for electricity production can be linked to the electricity use.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes:	Input	Cargo	Cargo	1.000000			tonne	Technosphere	
Notes:	Input	Refined resource	Electricity	.290000			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory

Publication	Lenner, M. \`Energiförbrukning och avgasemission för olika transporttyper\` VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	The Swedish Environmental Prot
General Purpose	To *facilitate a comparison* between energy use and environmental load for different types of transports.
Detailed Purpose	To compile data for current and future energy and exhaust emissions for different types of transports.
Commissioner	- The Swedish Environmental Protection Agency.
Practitioner	Lenner, Magnus - Väg- och transportforskningsinstitutet 581 95 Linköping .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	The data are only applicable for a goods train with 10 trucks, with average utilisation level of 80% of the available loading capacity. Lenner states that an average utilisation level of 40 % is stated by several sources in the literature while SJ maintains that the average use due to greater efficiency in recent years has been increased to over 80%. National values for environmental loadings for electricity production can be linked to the electricity use. The electricity use for goods transport by train is not expected to decrease. A minor reduction of losses can be obtained by replacement of old transformers and converters (the main losses are transmission, conversion and transformation losses).
About Data	The data were collected in the late 1970s, but are still assumed to be representative.
Notes	Lenners values are also used in: Tillman, A-M. \`Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.\` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995

SPINE LCI dataset: Rail transport - 10 trucks

Administrative

Finished	Y
Date Completed	1993-01-01

Copyright	
Availability	Public

Technical System	
Name	Rail transport - 10 trucks
Functional Unit	tonkm, 40 %
Functional Unit Explanation	The energy use is calculated with reference to the transportation of 1 ton goods, 1 kilometre for an utilisation level of 40%.
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of an electrically driven engine with 10 trucks.

System Boundaries	
Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS:
Time Boundary	The aim was that the data should be representative for 1992.
Geographical Boundary	Sweden and other countries with a similar rail system
Other Boundaries	Utilisation level with regard to weight: 40%. The energy use are only associated with the propulsion of the train *Not included in the system* Production and distribution of electricity Production and maintenance of the train and tracks
Allocations	PRINCIPLE APPLIED: DESCRIPTION:
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study)

Flow Data	
General Activity QMetaData	
Date Conceived	1979-1984
Data Type	Unspecified
Represents	These average values are based on three different types of the polymerisation of vinyl chloride monomer : - suspension polymerisation [14 plants in Europe] - emulsion polymerisation [5 plants in Europe] - bulk polymeriastion.
Method	The electricity use of 10 trucks with an average load factor of 40 % can be read in figure 2.3, page 11, Backman et al (1). Figure 2.3 shows the electricity use as a function of load (25 -100% of total load capacity). The energy use for propulsion are measured at the primary side of the converter station (50 Hz, 3-phase, 6.3 kV). The energy use to reverse the points are included as an average addition of 6 % to the energy use. The background for figure 2.3 can be found in Backman et al (2). It is however not stated in Backman et al (2) how the background material was retrieved.
Literature Reference	1. Backman, H., and Cordi, I. \`Energieffektivitet i framtidens godstransporter\` Transportforskningsdelegationen 1984:1 2. Cordi, I et al, \`Energieffektiviteten för person- och godstransporter i Sverige. En jämförande analys. Appendix.\` TFD-rapport 1979:2, Transportforskningsdelegationen, 1979
Notes	National values for environmental loadings for electricity production can be linked to the electricity use.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes:	Input	Cargo	Cargo	1.000000			tonne	Technosphere	
Notes:	Input	Refined resource	Electricity	.400000			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory	
Publication	Lenner, M. `Energiförbrukning och avgasemission för olika transporttyper` VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	The Swedish Environmental Prot
General Purpose	To *facilitate a comparison* between energy use and environmental load for different types of transports.
Detailed Purpose	To compile data for current and future energy and exhaust emissions for different types of transports.
Commissioner	- The Swedish Environmental Protection Agency.
Practitioner	Lenner, Magnus - Väg- och transportforskningsinstitutet 581 95 Linköping .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	The data are only applicable for a goods train with 10 trucks, with average utilisation level of 40% of the available loading capacity. Lenner states that an average utilisation level of 40 % is stated by several sources in the literature while SJ maintains that the average use due to greater efficiency in recent years has been increased to over 80%. National values for environmental loadings for electricity production can be linked to the electricity use. The electricity use for goods transport by train is not expected to decrease. A minor reduction of losses can be obtained by replacement of old transformers and converters (the main losses are transmission, conversion and transformation losses).
About Data	The data were collected in the late 1970s, but are still assumed to be representative.
Notes	Lenners values are also used in: Tillman, A-M. `Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995

SPINE LCI dataset: Rail transport - 52 trucks

Administrative	
Finished	Y
Date Completed	1993-01-01
Copyright	
Availability	Public

Technical System	
Name	Rail transport - 52 trucks
Functional Unit	tonkm, 40 %
Functional Unit Explanation	The energy use is calculated with reference to the transportation of 1 ton goods, 1 kilometre for an utilisation level of 40%.
Process Type	Unit operation
Site	
Sector	Land transport
Owner	
Technical system description	Operation of an electrically driven engine and 52 trucks

System Boundaries

Nature Boundary	
Time Boundary	The aim was that the data should be representative for 1992.
Geographical Boundary	Sweden and other countries with a similar rail system.
Other Boundaries	Utilisation level with regard to weight: 40%. The energy use are only associated with the propulsion of the train *Not included in the system* Production and distribution of electricity Production and maintenance of the train and tracks.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1979-1984
Data Type	Unspecified
Represents	These average values are based on three different types of the polymerisation of vinyl chloride monomer : - suspension polymerisation [14 plants in Europe] - emulsion polymerisation [5 plants in Europe] - bulk polymeriastion.
Method	The electricity use of 52 trucks with an average load factor of 40 % can be read in figure 2.3, page 11, Backman et al. Figure 2.3 shows the electricity use as a function of load (25 -100% of total load capacity). The energy use for propulsion are measured at the primary side of the converter station (50 Hz, 3-phase, 6.3 kV). The energy use to reverse the points are included as an average addition of 6 % to the energy use. The background for figure 2.3 can be found in Backman et al (2). It is however not stated in Backman et al (2) how the background material was retrieved.
Literature Reference	1. Backman, H., and Cordi, I. \`Energieffektivitet i framtidens godstransporter\` Transportforskningsdelegationen 1984:1 2. Cordi, I et al, \`Energieffektiviteten för person- och godstransporter i Sverige. En jämförande analys. Appendix.\` TFD-rapport 1979:2, Transportforskningsdelegationen, 1979
Notes	National values for environmental loadings for electricity production can be linked to the electricity use.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes:	Input	Cargo	Cargo	1.000000			tonne	Technosphere	
Notes:	Input	Refined resource	Electricity	0.29			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	

About Inventory

Publication	Lenner, M. \`Energiförbrukning och avgasemission för olika transporttyper\` VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	The Swedish Environmental Prot
General Purpose	To *facilitate a comparison* between energy use and environmental load for different types of transports.
Detailed Purpose	To compile data for current and future energy and exhaust emissions for different types of transports.
Commissioner	- The Swedish Environmental Protection Agency.
Practitioner	Lenner, Magnus - Väg- och transportforskningsinstitutet 581 95 Linköping .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	The data are only applicable for a goods train with 52 trucks, with average utilisation level of 40% of the available loading capacity. Lenner states that an average utilisation level of 40 % is stated by several sources in the literature while SJ maintains that the average use due to greater efficiency in recent years has been increased to over 80%. National values for environmental loadings for electricity production can be linked to the electricity use. The electricity use for goods transport by train is not expected to decrease. A minor

	reduction of losses can be obtained by replacement of old transformers and converters (the main losses are transmission, conversion and transformation losses).
About Data	The data were collected in the late 1970s, but are still assumed to be representative.
Notes	Lenners values are also used in: Tillman, A-M. `Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995

SPINE LCI dataset: Rail transport - 52 trucks

Administrative	
Finished	Y
Date Completed	1993-01-01
Copyright	
Availability	Public

Technical System	
Name	Rail transport - 52 trucks
Functional Unit	tonkm, 80 %
Functional Unit Explanation	The energy use is calculated with reference to the transportation of 1 ton goods, 1 kilometre for an utilisation level of 80%.
Process Type	Unit operation
Site	
Sector	Land transport
Owner	
Technical system description	Operation of an electrically driven engine with 52 trucks.

System Boundaries	
Nature Boundary	
Time Boundary	The aim was that the data should be representative for 1992.
Geographical Boundary	Sweden and other countries with a similar rail system.
Other Boundaries	Utilisation level with regard to weight: 80%. The energy use is only associated with the propulsion of the train *Not included in the system* Production and distribution of electricity Production and maintenance of the train and tracks
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1979-1984
Data Type	Unspecified, expert outspoke
Represents	These average values are based on three different types of the polymerisation of vinyl chloride monomer : - suspension polymerisation [14 plants in Europe] - emulsion polymerisation [5 plants in Europe] - bulk polymeriastion.

Method	The electricity use of 52 trucks with an average load factor of 80 % can be read in figure 2.3, page 11, Backman et al. Figure 2.3 shows the electricity use as a function of load (25 -100% of total load capacity). The energy use for propulsion is measured at the primary side of the converter (50 Hz, 3-phase, 6.3 kV). The energy use to reverse the points is included as an average addition of 6 % to the energy use. The background for figure 2.3 can be found in Backman et al (2). It is however not stated in Backman et al (2) how the background material was retrieved.
Literature Reference	1. Backman, H., and Cordi, I. \`Energieffektivitet i framtidens godstransporter\` Transportforskningsdelegationen 1984:1 2. Cordi, I et al, \`Energieffektiviteten för person- och godstransporter i Sverige. En jämförande analys. Appendix.\` TFD-rapport 1979:2, Transportforskningsdelegationen, 1979
Notes	National values for environmental loadings for electricity production can be linked to the electricity use.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes:	Input	Cargo	Cargo	1.000000			tonne	Technosphere	
Notes:	Input	Refined resource	Electricity	.220000			MJ	Technosphere	
	Output	Cargo	Cargo	1.000000			tonne	Technosphere	

About Inventory

Publication	Lenner, M. \`Energiförbrukning och avgasemission för olika transporttyper\` VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	The Swedish Environmental Prot
General Purpose	To *facilitate a comparison* between energy use and environmental load for different types of transports.
Detailed Purpose	To compile data for current and future energy and exhaust emissions for different types of transports.
Commissioner	- The Swedish Environmental Protection Agency.
Practitioner	Lenner, Magnus - Väg- och transportforskningsinstitutet 581 95 Linköping .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	The data are only applicable for a goods train with 52 trucks, with average utilisation level of 80% of the available loading capacity. Lenner states that an average utilisation level of 40 % is stated by several sources in the literature while SJ maintains that the average use due to greater efficiency in recent years has been increased to over 80%. National values for environmental loadings for electricity production can be linked to the electricity use. The electricity use for goods transport by train is not expected to decrease. A minor reduction of losses can be obtained by replacement of old transformers and converters (the main losses are transmission, conversion and transformation losses).
About Data	The data were collected in the late 1970s, but are still assumed to be representative.
Notes	Lenners values are also used in: Tillman, A-M. \`Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.\` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995

SPINE LCI dataset: Rape seed cultivation. ESA-DBP

Administrative

Finished	Y
Date Completed	2005

Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Rape seed cultivation. ESA-DBP
Functional Unit	1 ha of rape seed
Functional Unit Explanation	Assuming a yield with capacity of 3200kg/ha
Process Type	Cradle to gate
Site	Unknown
Sector	Food products and beverages
Owner	Unknown
Technical system description	Rape seed is an ingredient of 'Soy-Dog' which was an object of the study. This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Pea-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Pea cultivation. ESA-DBP - Production of beef. ESA-DBP - Production of pork. ESA-DBP - Wheat cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean processing. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries

Nature Boundary	Data include resources, use of energy, as well as emissions to water.
Time Boundary	The data were acquired in 2000.
Geographical Boundary	The study was done for Sweden.
Other Boundaries	Unknown
Allocations	No information about the allocation in the report.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2000
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from other report.
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf
Notes	National values for environmental loadings for electricity production can be linked to the electricity use.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***

Notes: For field operations	Input	Refined resource	Diesel	3.53E+03			MJ	Technosphere	Sweden
	Input	Refined resource	Esfenvalerat	1.00E+01			g	Technosphere	Sweden
	Input	Refined resource	Heat oil	8.47E+01			MJ	Technosphere	Sweden
	Input	Refined resource	K	2.80E+01			kg	Technosphere	Sweden
	Input	Refined resource	Metazaklor	5.00E+02			g	Technosphere	Sweden
	Input	Refined resource	N	1.60E+02			kg	Technosphere	Sweden
	Input	Refined resource	P	1.40E+01			kg	Technosphere	Sweden
	Output	Emission	N	4.20E+01			kg	Water	Sweden
	Output	Emission	P	3.00E-01			kg	Water	Sweden
	Output	Product	Rape seed field	1			ha	Ground	Sweden

About Inventory	
Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .
Practitioner	Anders Abelmann - Chalmers University of Technology.
Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Rapeseed lubricant

Administrative	
Finished	Y
Date Completed	2002-12-12
Copyright	
Availability	Public

Technical System

Name	Rapeseed lubricant
Functional Unit	910 kg of rapeseed lubricant
Functional Unit Explanation	910 kg was the amount that theUnspecified rapeseed lubricant.
Process Type	Cradle to grave
Site	Sweden
Sector	Process
Owner	Sweden
Technical system description	The activity contains cultivation of rapeseed, production of lubricant, transports as well as combustion of waste oil. The data set is compiled for a case study of the effect of environmentally friendly lubricants for roller bearings, see Detailed Purpose for more information. The data is collected from the thesis work ''Livscykelanalys'' by Anders Marby, KTH Ingenjörsskolan. The alcohol used to saponise the oil are not included. They are usually trimethylolpropane and neopentylglycol.

System Boundaries

Nature Boundary	The inflows that are refine resources are the fertilizers N, P and K, but also lime, sulphuric acid and oxygen used for electricity production. There are emissions to both technosphere, air and water included in the system.
Time Boundary	The data is collected from the thesis work ''Livscykelanalys'' by Anders Marby, KTH Ingenjörsskolan, from 1999.
Geographical Boundary	Sweden
Other Boundaries	The oil is not combusted in a waste incineration furnace. Care has to be taken to that many emissions could have been avoided if total combustion had occurred.
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002-08-30 - 2002-12-31
Data Type	Unspecified
Represents	Rapeseed oil for use as hydraulic oil in forest machines.
Method	From thesis by Anders Marby, see Literature Ref.
Literature Reference	Marby Anders; Livscykelanalys; KTH Ingenjörsskolan; 1999
Notes	National values for environmental loadings for electricity production can be linked to the electricity use.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Bentonite	12.33			mg	Ground	
	Input	Natural resource	Biomass	0.2257			kg	Ground	
	Input	Natural resource	Copper ore	2.55			g	Ground	
	Input	Natural resource	Crude oil	0.153			tonne	Ground	
	Input	Natural resource	Hard coal	0.497			kg	Ground	
	Input	Natural resource	Hydro power	4.36			g	Water	
	Input	Natural resource	Iron ore	0.8809			g	Ground	
	Input	Natural resource	Lead ore	0.3171			g	Ground	
	Input	Natural resource	Lignite	0.24			kg	Ground	
	Input	Natural resource	Natural gas	0.617			kg	Ground	
	Input	Natural resource	Natural gas, feedstock	110			kg	Ground	
	Input	Natural resource	Uranium	0.0349			g	Ground	
	Input	Natural resource	Water	0.0364			kg	Water	

	Input	Natural resource	Water	1.61			tonne	Water	
	Input	Natural resource	Wind power	9.27			mg	Air	
	Input	Natural resource	Wood	0.13			kg	Ground	
	Input	Refine resource	H2SO4	19.937			g	Technosphere	Sweden
	Input	Refine resource	K	28			kg	Technosphere	
	Input	Refine resource	Lime	11.962			g	Technosphere	Sweden
	Input	Refine resource	N total	160			kg	Technosphere	
	Input	Refine resource	Oxygen	139.094			g	Technosphere	Sweden
	Input	Refine resource	P	14			kg	Technosphere	
	Output	Cargo	CH4	6.02534			g	Technosphere	Sweden
	Output	Co-product	Cu	0.39			mg	Technosphere	Sweden
	Output	Emission	Acetylene	19.8			mg	Air	Sweden
	Output	Emission	Al	0.414			g	Water	Sweden
	Output	Emission	Alkanes	4.95			mg	Air	Sweden
	Output	Emission	Alkenes	39.6			mg	Air	Sweden
	Output	Emission	Aromates (C9-C10)	39.6			mg	Air	Sweden
	Output	Emission	As	0.229			g	Water	Sweden
	Output	Emission	As	0.268			mg	Air	Sweden
	Output	Emission	Benzene	0.37			g	Air	Sweden
	Output	Emission	BOD5	5.99			mg	Water	Sweden
	Output	Emission	Cd	0.222			g	Water	Sweden
	Output	Emission	Cd	0.551			mg	Air	Sweden
	Output	Emission	Cl-	0.39			kg	Water	Sweden
	Output	Emission	CN-	3.343			mg	Air	Sweden
	Output	Emission	CN-	31.8			mg	Water	Sweden
	Output	Emission	CO	0.19			kg	Air	Sweden
	Output	Emission	Co	0.81			mg	Water	Sweden
	Output	Emission	CO2	535			kg	Air	Sweden
	Output	Emission	COD	0.0771			kg	Water	Sweden
	Output	Emission	COD	0.124			g	Water	Sweden
	Output	Emission	Cr	0.57			mg	Air	Sweden
	Output	Emission	Cr	7.42			mg	Water	Sweden
	Output	Emission	Cr3+	0.557			mg	Air	Sweden
	Output	Emission	Cr3+	10			mg	Water	Sweden
	Output	Emission	Cu	6.75			mg	Water	Sweden
	Output	Emission	Dioxin (TCDD)	4.99E-06			mg	Air	Sweden
	Output	Emission	Dissolved solids	12.61			mg	Water	Sweden
	Output	Emission	Ethane	39.6			mg	Air	Sweden
	Output	Emission	Ethene	99			mg	Air	Sweden
	Output	Emission	F-	0.642			g	Air	Sweden
	Output	Emission	F-	2.89			mg	Water	Sweden
	Output	Emission	F-	23.3			g	Water	Sweden
	Output	Emission	Formaldehyde	1.19			mg	Air	Sweden
	Output	Emission	H2S	0.0104			mg	Water	Sweden
	Output	Emission	H2S	27.5			mg	Air	Sweden
	Output	Emission	HC	0.273			g	Air	Sweden
	Output	Emission	HCl	0.0143			g	Air	Sweden
	Output	Emission	Hexane	3.64			g	Air	Sweden
	Output	Emission	HF	0.313			g	Air	Sweden
	Output	Emission	Hg	0.00885			mg	Air	Sweden
	Output	Emission	Hg	0.214			g	Water	Sweden
	Output	Emission	Highly radioactive	4.1			g	Air	Sweden
	Output	Emission	Inert residues	0.8336			g	Air	Sweden
	Output	Emission	Low radioactive	12.5			tonne	Water	Sweden
	Output	Emission	Medium radioactive	12.5			tonne	Air	Sweden
	Output	Emission	N2O	25.7			g	Air	Sweden
	Output	Emission	NH3	0.060367			mg	Water	Sweden
	Output	Emission	NH3	20.8			g	Air	Sweden
	Output	Emission	Ni	0.446			mg	Water	Sweden
	Output	Emission	Ni	2.43			mg	Air	Sweden
	Output	Emission	NMVOC	108.662			g	Air	Sweden
	Output	Emission	NMVOC	5.89			g	Air	Sweden
	Output	Emission	NO2	76			g	Air	Sweden
	Output	Emission	NO3-	3.43			g	Water	Sweden
	Output	Emission	N-tot	42			kg	Water	Sweden

	Output	Emission	Oil	0.133			kg	Water	Sweden
	Output	Emission	Organics	0.111			kg	Water	Sweden
	Output	Emission	P total	0.3			kg	Water	
	Output	Emission	P2O5	0.621			g	Air	Sweden
	Output	Emission	P2O5	14.4			g	Water	Sweden
	Output	Emission	PAH	0.00228			mg	Air	Sweden
	Output	Emission	Particulates	3			g	Air	Sweden
	Output	Emission	Pb	21			mg	Air	Sweden
	Output	Emission	Pb	7			mg	Water	Sweden
	Output	Emission	PO43-	3.17			mg	Water	Sweden
	Output	Emission	PO43-	33.5			mg	Water	Sweden
	Output	Emission	Propane	59.4			mg	Air	Sweden
	Output	Emission	Propene	39.6			mg	Air	Sweden
	Output	Emission	Radioactive waste	58.6			mg	Air	Sweden
	Output	Emission	Rn-222	0.12333			tonne	Air	Sweden
	Output	Emission	Sb	0.114			mg	Water	Sweden
	Output	Emission	Se	0.00223			mg	Air	Sweden
	Output	Emission	Sn	0.891			g	Water	Sweden
	Output	Emission	SO2	6.31			g	Air	Sweden
	Output	Emission	SO42-	0.154			kg	Water	Sweden
	Output	Emission	Toluene	0.0198			g	Air	Sweden
	Output	Emission	Unspecified	13.168			kg	Air	Sweden
	Output	Emission	V	26.6			mg	Water	Sweden
	Output	Emission	VOC	0.3459			g	Air	Sweden
	Output	Emission	Zn	0.225			mg	Air	Sweden
	Output	Emission	Zn	9.69			mg	Water	Sweden
	Output	Product	Lubricating Oil	910			kg	Technosphere	
	Output	Residue	Gypsum	0.105			tonne	Technosphere	Sweden
	Output	Residue	Hazardous waste	0.403			kg	Technosphere	Sweden
	Output	Residue	Industrial waste	0.306			tonne	Technosphere	Sweden

About Inventory	
Publication	Marby Anders; Livscykelanalys; KTH Ingenjörsskolan; 1999 Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002. ------------------ Data documented by Sandra Häggström, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-03-21.
Intended User	Product developer at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The thesis includes case studies of environmental impacts if one or more measures are introduced in the use phase. One case study treats use of rapeseed oil.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	With care for unspecified rapeseed lubricants.
About Data	Data is collected from the thesis work: Marby, Anders; Livscykelanalys; KTH Ingenjörsskolan; 1999
Notes	

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	Rapeseed methyl ester (RME), cradle-to-gate, energy allocation - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of RME from rapeseed
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of RME valid for southern Sweden. The following process are covered: - Cultivation of the rapeseed - Harvest - Distribution to the fuel plant - Production of RME The production of RME is assumed to take place in plants in Karlshamn and Stenungsund. The mineral fertilizer used is assumed partly to be produced in Western Europe (about 60 %) with present level of cleaning equipment etc., and partly imported from countries outside Europe (about 40 %). This implies that about 30 % of the mineral fertilizer production takes place in plants with nitrous oxide cleaning where the nitrous oxide emission levels are reduced with about 80 %. All electricity input in the RME-plant is Swedish grid mix. Fuel used at the RME plant for is of forest origin. Allocation is made based on energy content (only case showed in Miljöfaktaboken, since this allocation method is preferred by the Renewable Energy Directive), however a case with system expansion is made in Börjesson et al. which also has been published in the f3 database. Transport distances are estimated based on southern Sweden conditions. The study is based on BAT (Best available technology). Capital goods are not included. Impacts from production of buildings and infrastructure are not included.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Cultivation of rapeseed (assumed on good soil) and handeling and storing of waste and manure is in Southern Sweden.
Other Boundaries	
Allocations	The outputs from the RME production are RME and the byproducts rapeseed meal and glycerol. Emissions and primary energy demand are all allocated between the RME and the byproducts. Energy allocation is based on the following energy contents: RME 37,2 MJ/kg, rapeseed meal 15,3 MJ/kg, glycerol 16,2 MJ/kg.
Systems Expansions	No.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	Rapeseed oil for use as hydraulic oil in forest machines.
Method	Literature studies

Literature Reference	Gode, J. et al., 2011, Miljöfaktaboken 2011, Uppskattade emissionsfaktorer för bränslen, el, värme och transporter, Värmeforsk Data in Gode et al. Are based on: Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH. But since data in Börjesson et al. is only given in impact categories not per emissions Gode et al. is used.
Notes	National values for environmental loadings for electricity production can be linked to the electricity use.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Only energy use, not the energy embedded in the product. Börjesson is not stating what different energy carriers that are included in the primary energy. There is no primary energy factor given.	Input	Resource	Primary energy	1.27			MJ	Ground	
	Output	Emission	Carbon dioxide (fossil)	0.0172			kg	Air	
	Output	Emission	Carbon monoxide	0.0000097			kg	Air	
Notes: Methane emissions can vary extensively between sites. These are average data for southern Sweden.	Output	Emission	Methane (biogenic)	0.0000121			kg	Air	
	Output	Emission	Nitrate	0.000546			kg	Water	
	Output	Emission	Nitrogen oxides	0.0000716			kg	Air	
	Output	Emission	Nitrous oxide	0.000021			kg	Air	
	Output	Emission	Non-methane volatile organic compounds	0.0000034			kg	Air	
	Output	Emission	Particles (unspecified)	0.0000058			kg	Air	
	Output	Emission	Sulfur dioxide	0.0000274			kg	Air	
	Output	Product	Rapeseed methyl ester (RME)	1			MJ	Technosphere	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	-
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Rapeseed methyl ester (RME), cradle-to-gate, system expansion, impact categories only - f3 fuels

Administrative

Finished	Y

Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System

Name	Rapeseed methyl ester (RME), cradle-to-gate, system expansion, impact categories only - f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ output of RME from rapeseed
Process Type	Cradle to gate
Site	
Sector	Fuel
Owner	
Technical system description	This dataset represents a model of the cradle to gate production of RME valid for southern Sweden. The following processes are covered: - Cultivation of the rapeseed - Harvest - Distribution to the fuel plant - Production of RME The production of RME is assumed to take place in plants in Karlshamn and Stenungsund. The mineral fertilizer used is assumed partly to be produced in Western Europe (about 60 %) with present level of cleaning equipment etc., and partly imported from countries outside Europe (about 40 %). This implies that about 30 % of the mineral fertilizer production takes place in plants with nitrous oxide cleaning where the nitrous oxide emission levels are reduced with about 80 %. All electricity input in the RME-plant is Swedish grid mix. Fuel used at the RME plant for is of forest origin. Data in Börjesson et al. are only published as impact categories and not as emissions except for particles.

System Boundaries

Nature Boundary	
Time Boundary	2010 - 2013
Geographical Boundary	Cultivation of rapeseed (assumed on good soil) and handeling and storing of waste and manure is in Southern Sweden.
Other Boundaries	
Allocations	By-products from the RME production are rapeseed meal and glycerol. 1 kg rapeseed meal (dry matter) is replacing 0.7 kg soybean meal and 0.3 kg barley. 1 kg glycerol is replacing 0.5 kg fossil-based and 0.5 kg bio-based chemicals. Reference: table 2 and figure 1.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	Rapeseed oil for use as hydraulic oil in forest machines.
Method	Raw materials: General - Processed official statistics Transformation: Mainly site-specific – Karlshamn & Stenungsund – Existing Reference: table 1
Literature Reference	Börjesson, P. et al., 2010, Life cycle assessment of biofuels in Sweden, Report nr 70 LTH.
Notes	National values for environmental loadings for electricity production can be linked to the electricity use.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: Not mentioned in Börjesson	Input	Resource	Primary energy				MJ	Ground	
Notes: Given as kg SO2-eq combined emissions. Table 10	Output	Emission	Acidification (AP)	-0.000127			kg	Air	
Notes: Given as kg PO4-eq combined emissions. Table 9	Output	Emission	Eutrophication (EP)	0.0002			kg	Air	
Notes: Given as kg CO2-eq combined emissions. Table 7	Output	Emission	Global warming (GWP)	0.0264			kg	Air	
Notes: Table 12	Output	Emission	Particles (unspecified)	0.00001			kg	Air	
Notes: Given as kg ethene-eq combined emissions. Table 11	Output	Emission	Photo-oxidant formation (POCP)	0.0000029			kg	Air	
	Output	Product	Rapeseed methyl ester (RME)	1			MJ	Technosphere	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisa Bolin (SP), Frida Røyn (SP).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Reconditioning of bearing

Administrative	
Finished	Y
Date Completed	2002-12-18
Copyright	
Availability	Public

Technical System	
Name	Reconditioning of bearing
Functional Unit	1.2 kg of bearing
Functional Unit Explanation	One SKF spherical roller bearing size 232/530 weighs 1.2 ton.
Process Type	Gate to gate
Site	SKF Service SKF Sverige AB, 415 50 Göteborg
Sector	
Owner	SKF Service SKF Sverige AB, 415 50 Göteborg

Technical system description	A bearing is used a certain period before it is dismounted and examined at the plant. If it looks ok it is sent for reconditioning, otherwise it is scrapped directly from the location where it is used. The bearing is examined visually to see if it has damages that are so severe that the bearing cannot be reused. If so it is scrapped. If no severe damages can be seen by the eye, the bearing is examined with ultrasound. If no cracks are discovered in this step either it is sent for polishing.

System Boundaries

Nature Boundary	The bearings, the lubricant, and the cleaning agent come from and leave to the technosphere. Emissions to air, water and ground were not included due to lack of data.
Time Boundary	Data is collected autumn 2002. No changes are planned for the nearest future.
Geographical Boundary	The reconditioning takes place at SKF in Göteborg.
Other Boundaries	
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002-11-29 - 2002-12-31
Data Type	Unspecified
Represents	N/A
Method	Interview with Jan Blomquist at SKF Service AB
Literature Reference	none
Notes	The bearings from Holmen Paper AB are reconditioned once during the bearings lifetime.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refine resource	Bearing	1.2			tonne	Technosphere	
Notes: 1 dl Castrol is used, density 0.76 kg/l.	Input	Refine resource	Castrol 86/27	0.076			kg	Technosphere	Sweden
Notes: The polishing takes 15-60 minutes depending on the damages. The average time needed for one rings is 40 minutes. Both the outer and inner ring are polished. The effect needed is 8 kW, 16 kW for both, so this number is multiplied with the time 40 minutes.	Input	Refine resource	Electricity	10.72			kWh	Technosphere	
	Output	Residue	Bearing	1.2			tonne	Technosphere	
	Output	Residue	Castrol 86/27	0.076			kg	Technosphere	Sweden
	Output	Residue	Mobil Glygoyle 30	0.4024			kg	Technosphere	Sweden

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002. ------------------- Data documented by Sandra Häggström, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-03-21.
Intended User	Product developer at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The purpose for our study is to compare a coated roller bearing to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.

Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	All bearings reconditioned at SKF Service AB in Göteborg, or with similar conditions.
About Data	The data is gathered interviewing Jan Blomquist at SKF Service AB.
Notes	

SPINE LCI dataset: Recycling and temporary storage of metals

Administrative	
Finished	Y
Date Completed	1995-03-01
Copyright	
Availability	Public

Technical System	
Name	Recycling and temporary storage of metals
Functional Unit	ton
Functional Unit Explanation	1 ton reprocessed iron and scrap-metal
Process Type	Gate to gate
Site	Stena Metall Återvinning AB Salsmästaregatan 20 422 46 Hisings Backa
Sector	Waste treatment
Owner	Stena Metall Återvinning AB Salsmästaregatan 20 422 46 Hisings Backa
Technical system description	The company recycles and stores scrap-metal. The recycling is done through sorting. The reprocessing of the purchased goods is done through sorting by hand and mechanical work. The reprocessed goods are temporarily stored to be delivered to steel and metal melting plants. Material such as transformers is not processed, but is transported to Stena Metal in Karlstad to be scrapped. Car batteries are temporary stored in stainless containers. The company may not store more than three containers at the site. When the quota is filled the containers are transported and delivered to Boliden Bergs;e in Landskrona.

System Boundaries	
Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	Unspecified
Represents	N/A
Method	Interview with Jan Blomquist at SKF Service AB
Literature Reference	none
Notes	The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Diesel	1.31061599			l	Technosphere	
	Input	Refined resource	Iron	0.896461337			tonne	Technosphere	
	Input	Refined resource	Metal	0.083879423			tonne	Technosphere	
	Input	Refined resource	Stainless steel	0.01965924			tonne	Technosphere	
Notes: The waste is disposed by GRAAB	Output	Residue	Industrial waste	0.018348624			g	Technosphere	

About Inventory

Publication	The environmental report from Stena Metal Återvinning AB for 1994, The Environmental Administration in the municipality of Göteborg. --- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Håkansson, Lars - Stena Metall Återvinning AB Salsmästaregatan 20 422 46 Hisings Backa.
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	There are more current environmental reports from the company, but those lack important information. In the environmental reports from 1995 and 1996 only the outgoing flows are specified. If one would like to use the data from the latest reports one would have to assume that the ingoing flows are the same for 1995 and 1996 as 1994, or try to find some kind of connection between the year and the ingoing flows. To use the first assumption would probably be a misstake, because earlier environmental reports show that the ingoing flows differ a lot between different years.
About Data	The company buy up steel and scrap-metal from industries and purchasers. 1994 the company bought 34 000 ton iron, 750 ton stainless-steel and 3200 ton metal.
Notes	

SPINE LCI dataset: Recycling of polyethene

Administrative

Finished	Y
Date Completed	1991
Copyright	
Availability	Public

Technical System

Name	Recycling of polyethene
Functional Unit	1 kg
Functional Unit Explanation	1 kg recycled polyethylene
Process Type	Gate to gate
Site	
Sector	Waste treatment
Owner	
Technical system description	The recycling process of polyethene involves grinding of the collected material, which is followed by washing, drying, extrusion and granulation of the grinded plastic.

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	Only the energy consumption, the material that is edmitted and the waste that is not recycleble are accounted for.
Allocations	Some emissions into water occur during recycling. The effluent goes to the authority sewage treatment plant. The primary source of the pollution is not plastic but remains of the contents of the packing. The contents are not part of the system and these emissions are therefore not accounted for.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1991
Data Type	Unspecified
Represents	N/A
Method	The data is based on Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Notes	The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	2.98			MJ	Technosphere	
	Input	Refined resource	Polyethylene	1			kg	Technosphere	
	Output	Product	Polyethylene	0.85			kg	Technosphere	
Method: The wastage during recycling is 15 % according to personal communication with Lars Karlson, Rosenlew Emballage AB.	Output	Residue	Polyethylene	0.15			kg	Technosphere	

Notes: The Polyethylene that is not recycleble is disposed of in landfill sites.									

About Inventory	
Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. --- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology ---
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study about packaging and the environment.
Detailed Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data are valid for Swedish conditions, but can be used as an approximation to other countries. One should though be aware of the fact that the situation in other countries may be very different and depending on this get one gets an unreliable result. The data are based on old sources and should therefore not be regarded as information describing the current situation. The emissions caused by the production of the electricity used in the system are not accounted for.
About Data	
Notes	

SPINE LCI dataset: Red brass sandcasting

Administrative	
Finished	Y
Date Completed	1995
Copyright	Metall/ Berlin Metall Verla 1947-
Availability	Full availability

Technical System	
Name	Red brass sandcasting
Functional Unit	1 kg cast red brass
Functional Unit Explanation	
Process Type	Gate to gate
Site	Germany
Sector	Materials and components
Owner	Germany

Technical system description	Pure metal and block metal is transported, melted, cast and cleaned. The numbers are an average of three different data sets which in turn are averges of German industry. Red brass are alloys with copper, tin, zink and lead in different compositions but with a high copper content, approximately 85%. Approximately 50% of the raw material used for the red brass is recycled material. Also approximately 800 g of sand is needed for the casting of 1 kg of red brass. Some of the sand is recycled.

System Boundaries

Nature Boundary	Not given
Time Boundary	Not given
Geographical Boundary	Germany
Other Boundaries	Not given
Allocations	Not given
Systems Expansions	Not given

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified, expert outspoke
Represents	German copper industry
Method	Not given
Literature Reference	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440.
Notes	The total primary energy required for transporting, melting, casting and cleaning is 15.3 MJ/kg product. For the melting induction and fossil fuel heated furnaces are used. For electricity a German electricity mix is used and described (in wastes and emissions) as well as the energy from fossil sources. Values in terms of MJ/kg for different transports are given with the specific emissions connected to them. The energy use for a number of help materials is included. Only small amounts of water are used.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	By-product	Copper slag and fly ash	0.1			kg	Technosphere	
	Output	Emission	CO	3.18			g	Air	
	Output	Emission	CO2	0.92			kg	Air	
	Output	Emission	HC	0.82			g	Air	
	Output	Emission	NO2	3.78			g	Air	
	Output	Emission	Particles	1.15			g	Air	
	Output	Emission	SO2	1.07			g	Air	
	Output	Residue	Ashes	0.03			kg	Ground	
	Output	Residue	Gypsum	0.01			kg	Ground	
	Output	Residue	Sand	1.59			kg	Ground	

About Inventory

Publication	K.H. Bruch, D. Gohlke, C. Kögler, J. Kruger, M. Reuter, I. v. Röpenack, E. Rombach, G. Rombach, P. Winkler. Sachbilanz einer Ökobilanz der Kupfererzeugung und - verarbeitung, Teil 1. Metall 49(1995)4, 252-257, Teil 2. Metall 49(1995)5, 318-324, Teil 3. Metall 49(1995)6, 434-440. -- Data documented by: Alena Ashkin, ABB Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Life cycle assessments
General Purpose	Increase knowledge about environmental impacts from copper industry
Detailed Purpose	Supply specialists in the field with data for life cycle assessments

Commissioner	- Deutsche Kupfer-Institut Dusseldorf, Wirtshaftsvereinigung Metall e. V. and various industrial companies.
Practitioner	- Institut fur Metallhuttenwesen und Elektrometallurgie der RWTH, Aachen Germany .
Reviewer	- None
Applicability	Can be used for western industrial countries. Best available technology in western Germany.
About Data	
Notes	For production of red brass pure metals and block metal are added in different proportions. Energies and emissions for producing those have to be included when making a cradle to gate assessment.

SPINE LCI dataset: Refinery in crude oil based LDPE production process. ESA-DBP

Administrative	
Finished	Y
Date Completed	2009
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Refinery in crude oil based LDPE production process. ESA-DBP
Functional Unit	1.2 kg of naphtha
Functional Unit Explanation	1.2 kg of naphtha is needed to produced 1 kg of LDPE which was the object of the study.
Process Type	Other
Site	Shell Raffinaderi AB Göteborg
Sector	Fuel
Owner	Shell Raffinaderi AB Göteborg
Technical system description	Refinery discussed in this study is one of the steps of crude oil based LDPE (low density polyethylene) production process. This process is a unit operation but the electricity and fuel used in this process are traced back to the cradle. In this step the crude oil is processed into the naphtha. Excerpt from the report, see 'Publication': ''Before the refining can start, contaminants (water, inorganic salts or suspended solids) must be removed. This is done by desalting. There are two different desalting processes. One is chemical desalting. In this process, the crude oil is mixed with water and surfactants and heated up. This causes dissolving or attaching of the impurities to the water and finally their settle out. The other process is electrical desalting. It includes the exposure of the oil to high-voltage electrostatic charges, which promotes the concentration of impurities on the bottom of the storage tank. After this pretreatment the refining starts with the preheating of the crude oil up to 220-250ºC (in heat exchangers fed with recovered heat from the refining process). A further heating up to the column temperature (360-380ºC) follows in a furnace (crude heater) before the oil enters the column. In the column (atmospheric column) the partially vaporized oil is separated into, side and bottom products. Part of the top product is used as reflux for the column. The reminder goes to the naphtha hydrotreater. The other products go to the strip-ping columns, in the case of the side products resp. to the vacuum column for the bottom product. The hydrotreatment is the removal of sulfur components in the top product. The later is mixed with hydrogen-rich gas, then heated up and lead through a catalyst bed. In the catalyst bed, the sulfur reacts with the hydrogen to hydrogen sulfide which is then separated in the subsequent separation steps. The first step is a high pressure separation used to recover the not reacted hydrogen. The second step is a low pressure separation in which the hydrogen sulfur is removed. Finally, the hydrotreated top product is stabilized and the naphtha is separated from the rest of the

	top product in a gasoline splitter.'' This process is included in the system described in: Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2009--14.pdf Other processes in the CPM Database also included in the above publication:

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''Outputs accounted for in this study were by-products and emissions released to air. Water emissions were omitted, because of data unavailability for some parts of the sugarcane route.'' The data relate also to the fuel and electricity consumption which were traced back to the cradle.
Time Boundary	Data for refinery come from 2007 and they were acquired as the most up-to-date ones.
Geographical Boundary	Data are valid for Sweden but for electricity calculations average European data were used.
Other Boundaries	Excerpt from the report, see 'Publication': ''products stated under 'bensinprodukter' are treated as naphtha - all data are calculated on this value
Allocations	Excerpt from the report, see 'Publication': ''allocation between naphtha and other products based on weight ; naphtha share = 0,26''
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2007
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''For the refining process, data for energy consumption and on-site emissions from the Shell Raffinaderi AB Göteborg (2007) were used. The environmental impact related to electricity supply was assessed using the already stated data.''
Literature Reference	Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2009--14.pdf
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Crude oil	1.30E+03			g	Technosphere	Sweden
	Input	Refined resource	Electricity	6.00E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Fuel	3.20E+00			MJ	Technosphere	Sweden
	Output	Emission	CH4	1.00E-01			g	Air	Sweden
	Output	Emission	CO	1.20E-02			g	Air	Sweden
	Output	Emission	CO2	2.13E+02			g	Air	Sweden
	Output	Emission	N2O	7.10E-04			g	Air	Sweden
	Output	Emission	NMVOC	9.30E-04			g	Air	Sweden
	Output	Emission	NOx	2.00E-01			g	Air	Sweden
	Output	Emission	SO2	2.00E-01			g	Air	Sweden
	Output	Emission	VOC	5.00E-01			g	Air	Sweden
	Output	Product	Naphtha	1.20E+03			g	Technosphere	Sweden

About Inventory

Publication	Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2009--14.pdf
Intended User	LCA practitioner

General Purpose	Excerpt from the report, see 'Publication': ''The goal of this study is to answer the question, is the use of sugarcane based LDPE in the production of goods and packing in Sweden environmentally preferable to crude oil based LDPE.''
Detailed Purpose	Refinery is a step in the production process of LDPE so it was necessary to investigate the environmental load of it.
Commissioner	Unknown - .
Practitioner	Christin Liptow & Anne-Marie Tillman - Environmental Systems Analysis, Chalmers University of Technology.
Reviewer	Tillman, Anne-Marie - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Refinery is a step in a production process of oil based LDPE which was the object of the study. The production process starts with crude oil extraction and is followed by refinery, steam cracking, polymerization, use phase (which was excluded from the study) and inceneration as the end of life. Oil based- was compared in the study to the sugarcane based- LDPE. NB: in the report two approaches were investigated: attributional and consequential. For consequential approach see the report.

SPINE LCI dataset: Refining of crude oil

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	Public

Technical System	
Name	Refining of crude oil
Functional Unit	1 kg
Functional Unit Explanation	1 kg refined oil product.
Process Type	Gate to gate
Site	Scanraff Lysekil
Sector	Materials and components
Owner	Scanraff Lysekil
Technical system description	The refining of oil starts with destillation, where light fractions are separated from the heavier ones. Examples of lighter fractions gas, naphtha, gasoline and paraffin. Heavier fractions are diesel, followed by heavy fuel oils and residues. Cracking then enables the portions of light fractions to be increased. Some of the crude oil, which arrives at the refinery is used initially as process fuel i.e. for distillation and cracking, while some of it is lost via process emissions to air and water. The crude oil is desulphurised in order to obtain products with lower sulphur content.

System Boundaries	
Nature Boundary	The emissions to air and water are the only parameters that are accounted for. The emissions are caused by: flaring, handling of waste process water, surface water and ballast water, diffuse emissions, desulphurisation of the crude oil and burning of internal fuel.
Time Boundary	
Geographical Boundary	
Other Boundaries	Energy consumption and the raw material used are accounted for.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1990
Data Type	Unspecified
Represents	See 'Function'
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992., where they have used data from Scanraff, environmental report 1990, Lysekil
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. Scanraff, environmental report 1990, Lysekil.
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Crude oil	1.0446			kg	Technosphere	
Notes: Used as internal fuel	Input	Refined resource	Crude oil	2.0055			MJ	Technosphere	
Method: The figure comes from Shell Raffinaderi AB, environmental report 1990, Göteborg	Input	Refined resource	Electricity	0.12			MJ	Technosphere	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	Aromatics	0.241			mg	Water	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	BOD-7	6.387			mg	Water	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	Cd	6.64			ug	Water	
Notes: Carbon dioxide emissions occur during burning of internal fuel and during flaring.	Output	Emission	CO2	108.11			g	Air	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	COD	49.7			mg	Water	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	Cyanide	0.0121			mg	Water	
Notes: Hydrocarbon emissions derive mainly from diffuse emissions and also to a small extent from what is not burning off in the flares.	Output	Emission	HC	0.3545			g	Air	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	Hg	0.02415			ug	Water	
Method: The total amount of internal fuel burnt during the whole year is 16620*10exp12 J and the amount fuel per kg refined oil product is 2,0055*10exp6 J. The total amount of Ni	Output	Emission	Ni	0.00989			ug	Air	

emissions per year is 820 kg. If the last figure is devided by the total amount fuel and then multiplied with the amount fuel per kg product the amount in the table is produced. Notes: The heavy metal (nickel and vanadium) are present in the oil, and emissions occur in combustion.									
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	Ni	24.75			ug	Water	
Notes: The NOx emissions come from burning of internal fuel.	Output	Emission	NOx	0.149			g	Air	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	N-tot	8.210			mg	Water	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	Oil	1.255			mg	Water	
Notes: Particulate emissions arise from catalytic cracking and in the burning of internal fuel.	Output	Emission	Particulates	0.0167			g	Air	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	Pb	11.47			ug	Water	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	Phenol	0.0241			mg	Water	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	P-tot	0.133			mg	Water	
Notes: Sulphur emissions come largely from burning of internal fuel and from the desulphuration plant.	Output	Emission	SO2	0.5423			g	Air	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	Susp solids	7.232			mg	Water	
Method: The total amount of internal fuel burnt during the whole year is 16620*10exp12 J and the amount fuel per kg refined oil product is 2,0055*10exp6 J. The total amount of V emissions to air per year is 2640 kg. If the last figure is devided by the total amount fuel and then multiplied with the amount fuel per kg product the amount in the table is produced. Notes: The heavy metal (nickel and vanadium) are present in the oil, and emissions occur in combustion.	Output	Emission	V	0.319			ug	Air	
Notes: Emissions to water arrise from the waste process water and surface water and also to some extent the ballast water.	Output	Emission	V	16.9			ug	Water	
	Output	Product	Refined oil products	1			kg	Technosphere	

About Inventory	
Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. --- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology ---
Intended User	A Life Cycle Assessment practi
General Purpose	The data set is part of a study conserning packaging and the environment.
Detailed Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	

Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data are based on old sources and should therefore not be regarded as information describing the current situation. The emissions for the production of the electricity used in the system is not accounted for. The emissions for the burning of internal fuel (crude oil) are accounted for.
About Data	
Notes	

SPINE LCI dataset: Refining of crude oil in to diesel

Administrative	
Finished	Y
Date Completed	1996
Copyright	
Availability	Public

Technical System	
Name	Refining of crude oil in to diesel
Functional Unit	1 MJ
Functional Unit Explanation	The amount of diesel environmental class 1 containing the energy amount 1 MJ.
Process Type	Gate to gate
Site	Scanraff (Skandinaviska Raffinaderi AB)
Sector	Fuel
Owner	Scanraff (Skandinaviska Raffinaderi AB)
Technical system description	The system involves the refinery Scanraff, which produces diesel environmental class 1 from crude oil. Scanraff is a refinery situated at Broviken. It is the largest and most advanced in Sweden. Scanraff is also considered to be the most environmental friendly refinery in Sweden at this moment in time (1997). In the refinery petrol, diesel, LPG and MTBE are produced from crude oil. The refining A refinery consists of the following parts: -Harbour where the crude oil is unloaded -Storage of the crude oil in tanks and rock shelters -Crude oil distillation including desalination -Vacuumdestillation of heavy (viscous) oil -Visbreaker -Catalytic cracking of heavy oil -Light hydrocracking -Synsat plant -Naphtha desulphurization -Catalytic reforming of petrol components -Polymerization plant -Isometrization plant -LPG-extraction -Merox for paraffin, heavy naphtha and LPG -Amine treatment -Sulphur recycling including -Tail gas plant -Equipment for steam production -Cooling system -Torching system

	-Tanks, spheres and rock shelters used for storage of products -Harbour where the products are shipped away Because of the location of Scanraff the waste heat can not be used for central heating.

System Boundaries

Nature Boundary	Emissions and energy consumption is accounted for in the table.
Time Boundary	The data describes the current situation, and will be inaccurate in another context.
Geographical Boundary	Sweden
Other Boundaries	No concern has been taken about waste heat, because the geographical situation decides how the waste water can be used, for example as district heating. In the case of Scanraff this is not possible. The production and transporting of the raw material (crude oil) are not part of the system.
Allocations	Because the integrated nature of a refinery it is difficult to allocate emissions and energy consumption to the different steps in the process of getting the final products. The energy consumption and emissions are therefore allocated to the final product, which in this case is diesel environmental class 1.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	
Represents	See 'Function'
Method	Literature study of Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5, where the data are taken from The environmental report from Scanraff for 1995. No further information about the selection of a possible translation is given in the report
Literature Reference	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Crude oil	1			MJ	Technosphere	
	Input	Refined resource	Electricity	0.0031			MJ	Technosphere	
	Input	Refined resource	Oil	0.032			MJ	Technosphere	
	Output	Emission	CO	0.15			mg	Air	
	Output	Emission	CO2	1594.49			mg	Air	
	Output	Emission	NMHC	5.67			mg	Air	
	Output	Emission	NOx	1.65			mg	Air	
	Output	Emission	SOx	1.05			mg	Air	
	Output	Emission	Susp solids	0.18			mg	Air	
	Output	Product	Diesel	1			MJ	Technosphere	

About Inventory

Publication	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5. --- Data documented by: Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	The data is taken from a life
General Purpose	

Detailed Purpose	The data are part of a study, which evaluates different fuels.
Commissioner	- KFB Komunikations Forsknings Beredningen Box 5706 Linnégatan 2 114 87 Stockholm Sweden.
Practitioner	Blinge Magnus, Arnäs P, Bäckström S, Furnander Å, Hovelius K - Department of Transportation and Logistics Chalmers University of Thechnology.
Reviewer	
Applicability	To get more information about the crude oil, which is used in the process of making petrol one can use data from the activities Extraction of crude oil and Transportation of crude oil to Sweden. The first activity describes the environmental load, in form of emissions and energy consumption, for extraction of off shore crude oil in Norway. If this data is used one must be aware of the fact that Scanraff does not entirely use crude oil from Norway. Only approx. half of the crude oil used at that refinery comes from Norway. The remaining part comes from countries with less environmental restrictions and with not so advanced technology. This implies that the environmental load given from these data is most probably lower than the real load at Scanraff. The crude oil is imported mostly from Norway (49% of the total amount crude oil imported to Sweden comes from Norway). All oil coming from Norway is off shore produced crude oil. The rest of the crude oil comes from the following countries in the following amounts: Iran 11%, Lettland 8%, Venezuela 8%, South Arabia 6%, Denmark 6%, Egypt 6%, Nigeria 3% and other countries 3%. The Norwegian data regarding the figures for extraction of crude oil is considered to be reliable, because of the harsh legislation from the Norwegian government. The second activity mentioned above describes the environmental load due to transporting crude oil to Sweden. In this activity account is taken to the fact that Sweden imports oil from different parts of the world in different amounts. If the environmental load for the electricity used in the system the following information should be used: When producing electricity emissions are let out. The electricity consumption in the table are given emission factors due to the mix of different kinds of electricity produced in and imported to Sweden during 1995. The following figures are used: CO_2 6891 mg/MJ CO 4,2 mg/MJ NO_x 11,7 mg/MJ NMHC 6,50 mg/MJ SO_x 9,7 mg/MJ Subs. solids 1,5 mg/MJ The figures come from Vattenfall Energisystem AB, 1997, through personal conversation with Ulrika Dethlefsen (08-7395588)
About Data	The data in the tables are found in the environmental report from Scanraff for 1995 or comes from personal contacts with fuel experts from Scanraff. The production at Scanraff 1995 The amount of processed raw material (97,6% crude oil): 9,7 million tons Crude oil: 97,6% Propane and Butane: 0,103% Condensate: 0,134% Naphtha: 0,904% MTBE: 0,257% Gas oil: 0,103% RUFO: 0,308% Ballast oil and additives: 0,0205% Rests: 0,586% The amount raw material put into catalytic cracking: 1,49 million tons The amount raw material put into the visbreaker: 1,38 million tons The amount raw material put into MHC plant 2,58 million tons The amount raw material put into the synsat plant 1,75 million tons The amount raw material put into the naphtha desulphurization: 1,98 million tons The amount raw material put into the isomerization: 0,41 million tons The total emissions from Scanraff 1995 CO_2: 0,95 Mton CO: 82 ton NO_x: (counted as NO_2) 980 ton SO_2: 619,4 ton (corresponds to 310 ton sulphur) NMHC: 3400 ton CH_4: negligible Dust: 108 ton

Notes	

SPINE LCI dataset: Refining of crude oil in to petrol

Administrative	
Finished	Y
Date Completed	1996
Copyright	
Availability	Public

Technical System	
Name	Refining of crude oil in to petrol
Functional Unit	1 MJ
Functional Unit Explanation	The amount of petrol containing the energy amount 1 MJ.
Process Type	Gate to gate
Site	Scanraff (Skandinaviska Raffinaderi AB)
Sector	Fuel
Owner	Scanraff (Skandinaviska Raffinaderi AB)
Technical system description	The system evolves the refinery Scanraff, which produces petrol from crude oil. Scanraff is a refinery situated at Broviken. It is the largest and most advanced in Sweden. Scanraff is also considered to be the most environmental friendly refinery in Sweden at this moment in time (1997). In the refinery petrol, diesel, LPG and MTBE are produced from crude oil. The refining A refinery consists of the following parts: -Harbour where the crude oil is unloaded -Storage of the crude oil in tanks and rock shelters -Crude oil distillation including desalination -Vacuumdestillation of heavy (viscous) oil -Visbreaker -Catalytic cracking of heavy oil -Light hydrocracking -Synsat plant -Naphtha desulphurization -Catalytic reforming of petrol components -Polymerization plant -Isometrization plant -LPG-extraction -Merox for paraffin, heavy naphtha and LPG -Amine treatment -Sulphur recycling including -Tail gas plant -Equipment for steam production -Cooling system -Torching system -Tanks, spheres and rock shelters for storage of products -Harbour where the products are shipped away Because of the location of Scanraff the waste heat can not be used for central heating.

System Boundaries	
Nature Boundary	Emissions and energy consumption is accounted for in the table. Transportation and production of crude oil are not parts of the system.
Time Boundary	The data describes the current situation, and will be inaccurate in other context.

Geographical Boundary	Sweden
Other Boundaries	No concern has been taken about waste heat, because the geographical situation decides how the waste water can be used, for example as district heating. In the case of Scanraff this is not possible.
Allocations	Because the integrated nature of a refinery it is difficult to allocate emissions and energy consumption to the different steps in the process of getting the final products. The energy consumption and emissions are therefore allocated to the final product, which in this case is petrol.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1995
Data Type	Unspecified
Represents	See 'Function'
Method	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5 has used the following litterature: Skandinaviska Raffinaderi AB, 1995, Environmental report and annual report, The Board of County in Göteborg and Bohus, The Department of Environment, 403 40 Gothenburg.
Literature Reference	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1995 Notes: To get more information about the crude oil see the activities Extraction of crude oil and Transportation of crude oil to Sweden.	Input	Refined resource	Crude oil	1			MJ	Technosphere	
	Input	Refined resource	Electricity	0.004322			MJ	Technosphere	
	Input	Refined resource	Oil	0.0623			MJ	Technosphere	
	Output	Emission	CO	0.2954			mg	Air	
	Output	Emission	CO2	3443.97			mg	Air	
	Output	Emission	NMHC	11.5326			mg	Air	
	Output	Emission	NOx	3.366			mg	Air	
	Output	Emission	SOx	2.137			mg	Air	
	Output	Emission	Susp solids	0.3718			mg	Air	
	Output	Product	Petrol	1			MJ	Technosphere	

About Inventory

Publication	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5. -- Data documented by: Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The data is taken from a life
General Purpose	
Detailed Purpose	The data is part of a larger study about different alternative fuels.
Commissioner	- KFB Komunikations Forsknings Beredningen Box 5706 Linnégatan 2 114 87 Stockholm Sweden.
Practitioner	Blinge Magnus, Arnäs P, Bäckström S, Furnander Å, Hovelius K - Department of Transportation and Logistics Chalmers University of Thechnology.
Reviewer	

Applicability	To get more information about the crude oil, which is used in the process of making petrol one can use data from the activities ''Extraction of crude oil'' and ''Transportation of crude oil to Sweden''. The first activity describes the environmental load, in form of emissions and energy consumption, for extraction of off shore crude oil in Norway. If this data is used one must be aware of the fact that Scanraff does not entirely use crude oil from Norway. Only approx. half of the crude oil used at that refinery comes from Norway. The remaining part comes from countries with less environmental restrictions and with not so advanced technology. This implies that the environmental load given from these data is most probably lower than the real load at Scanraff. The Norwegian data concerning the crude oil production is considered to be reliable, because of the strict legislation from the Norwegian government. The second activity mentioned above describes the environmental load due to transporting crude oil to Sweden. In this activity account is taken to the fact that Sweden imports oil from different parts of the world in different amounts. The crude oil is imported mostly from Norway (49% of the total amount crude oil imported to Sweden comes from Norway). All oil coming from Norway is off shore produced crude oil. The rest of the crude oil comes from the following countries in the following amounts: Iran 11%, Lettland 8%, Venezuela 8%, South Arabia 6%, Denmark 6%, Egypt 6%, Nigeria 3% and other countries 3%. If the load of the used electricity is to be calculated the following information should be used: When producing electricity emissions are let out. The electricity consumption in the table are given emission factors due to the mix of different kinds of electricity produced in and imported to Sweden during 1995. The following figures are used: CO2 6891 mg/MJ CO 4,2 mg/MJ NOx 11,7 mg/MJ NMHC 6,50 mg/MJ SOx 9,7 mg/MJ Subs. solids 1,5 mg/MJ The figures come from Vattenfall Energisystem AB, 1997, through personal conversation with Ulrika Dethlefsen (08-7395588)
About Data	The data in the tables are found in literature or comes from personal contacts with fuel experts at Scanraff, and their environmental report from 1995. The production at Scanraff 1995 The amount of processed raw material (97,6% crude oil): 9,7 million tons Crude oil: 97,6% Propane and Butane: 0,103% Condensate: 0,134% Naphtha: 0,904% MTBE: 0,257% Gas oil: 0,103% RUFO: 0,308% Ballast oil and additives: 0,0205% Rests: 0,586% The amount raw material put into catalytic cracking: 1,49 million tons The amount raw material put into the visbreaker: 1,38 million tons The amount raw material put into MHC plant 2,58 million tons The amount raw material put into the synsat plant 1,75 million tons The amount raw material put into the naphtha desulphurization: 1,98 million tons The amount raw material put into the isomerization: 0,41 million tons The total emissions from Scanraff 1995 CO2: 0,95 Mton CO: 82 ton NOx: (counted as NO2) 980 ton SO2: 619,4 ton (corresponds to 310 ton sulphur) NMHC: 3400 ton CH4: negligible Dust: 108 ton
Notes	

SPINE LCI dataset: Reinforcement bar production

Administrative	
Finished	Y
Date Completed	1997-05-01
Copyright	
Availability	Public

Technical System	
Name	Reinforcement bar production
Functional Unit	kg
Functional Unit Explanation	1 kg reinforcement bars
Process Type	Gate to gate
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	The data for reinforcement bar production is approximated with the allocation method for reinforcement steel production togehter with scrap- and orebased steel production. You can find the method for the reinforcement steel allocation in this Database at: Name: Swedish reinforcement steel mix Category: Other Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden You can find the data for scrap- and orebased steel in this Database at: Name: Scrap-based steel production Category: Gate to gate Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden Name: Ore-based steel production Category: Cradle to gate Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden

System Boundaries	
Nature Boundary	This study includes environmental loadings such as material resources, resources for energy production, waste and emissions to air and water.
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	Estimated from similarity
Represents	The environmental load for the production of reinforcement bars has been approximated with the one for reinforcement steel.
Method	Approximation
Literature Reference	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden

Notes	The environmental load for the production of reinforcement bars has been approximated with the one for reinforcement steel. You can find the data for reinforcement steel in this Database at: Name: Swedish reinforcement steel mix Category: Other Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Reinforcement steel	1			kg	Technosphere	
	Output	Product	Reinforcement bar	1			kg	Technosphere	

About Inventory

Publication	LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund, Tillman; Report 1997:2; TEP; CTH; Göteborg; Sweden -- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology --
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural wooden and concrete frames in buildings during the whole life cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of reinforcement bars
Commissioner	- Finncement Finland .
Practitioner	Björklund Thomas, Tillman Anne-Marie - Technical Environmental Planning, CTH 412 96 Göteborg Sweden.
Reviewer	
Applicability	The environmental load for the production of reinforcement bars has been approximated with the one for reinforcement steel. You can find the data for reinforcement steel in this Database at: Name: Swedish reinforcement steel mix Category: Other Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden
About Data	
Notes	

SPINE LCI dataset: Relay assembly

Administrative

Finished	Y
Date Completed	2000-03-09
Copyright	Ericsson
Availability	Official

Technical System

Name	Relay assembly

Functional Unit	One gram relay for mounting on printed circuit boards
Functional Unit Explanation	The motivation for choosing this functional unit is: · Suitable unit to work with in an LCA of a private branch exchanges (a complicated telecom product) · Important component of the MD110 product system and many other electronic products. DESIGN Both answers from component manufacturer one (CM1) and component manufacturer two (CM2) are for exactly the same component. These facts are based on Ericsson technical specification of the component. Ericsson product number: RAV 954 Ericsson description: RELAY RAV 954 General technical specification Monostable relay for mounting on printed circuit boards. The soldering tags are tin coated. The relay: -is position independent. -is designed for tight packaging placed in modul pitch -is dust and liquid proof -is fixed and connected to the printed board by sodlering. -has twin contacts. -has 2 break before make functions Dimensions: Module (M) = 2.54 mm Weight: app. 1.5 grams according to Ericsson. Height: 6 mm Width: 9.3 mm Length: 14.3 mm
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of relay for mounting on printed circuit boards. The activity is an average based on information acquired from two manufacturers. The description of the process is supplied by manufacturer one, but is assumed to be general for this type of manufacture. The following process steps are included; 1. Press working of iron 2. Degreasing 3. Heat Treatment 4. Plating 5. Welding 6. Injection Molding 7. Cutting and Bending 8. Covering 9. Sealing 10. Winding 11. Soldering Details given: 1. Press working of iron: Punch to form piece parts. 2. Degreasing: . Pure iron parts are degreased with pure water which is provided from waste water recycling equipment. Phospor bronz parts are degreased with alkaline solution. 3. Heat Treatment: Heat to get magnetic characteristics with N2 and H2. This process is done at a heat treatment subcontractor. 4. Plating: Chemical nickel plating is done to make magnetic residual characteristics and an oxidation prevention layer. This process is done at a subcontractor. 5. Welding: Weld to connect two parts. 6. Injection Molding: In our process, metal parts are set up in plastic to be one unit. 7. Cutting and Bending: Work to get needed shape. 8. Covering: A plastic cover is mounted on the relay to cover the movement.

	9. Sealing: Seal to keep constant atmosphere inside the relay. 10. Winding: Wire winding to make electromagnet. 11. Soldering: Dipping in solder bath to make solder covered terminal.

System Boundaries

Nature Boundary	The emissions to air and water have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impact has been studied. Included component manufacturers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used.
Time Boundary	1998 The answer from the manufacturer arrived in 1998 and they measured in 1998. The process technology used is most certainly the best available as the factories are located in Japan and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturers included in the average are located in Japan.
Other Boundaries	Delimitation’s to the system is the final step in the making of the relay. The production of the subparts (e.g. liquid crystalline polymer, copper alloy, permanant magnet and gold alloy) of the resistor is not included in this model. The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	The environmental load for the production of reinforcement bars has been approximated with the one for reinforcement steel.
Method	The data that are presented are calculated as an average based on information from two component manufacturers. The information from the manufacturers was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers In the information supplied by the manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+.+.ACn Step 2: The sum AC11+.+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to two answers was made.
Literature Reference	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden
Notes	The environmental load for the production of reinforcement bars has been approximated with the one for reinforcement steel. You can find the data for reinforcement steel in this Database at: Name: Swedish reinforcement steel mix Category: Other Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*

	Date concieved: 1998 Data type: Derived, unspecified Method: CM1 : 340 dm3 = 0,34 m3 Weight of one relay: 4,36 g Density of air: 1,29 kg/m3 (ISBN 91-27-72174-4, page 72) (Stated as 340 litres of Compressed air by CM1) (0,34*1,29*1000) g Air/4,36 g relay = 100,6 Air g/g relay This is not an average value and the figure is based only on one answer. Literature: ISBN 91-27-72174-4 page 71. Notes: CM1 states a consumption of compressed air of 340 litres.	Input	Refined resource	Air	100.6			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 4.2/4360 = 0.00096 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	AuAg alloy	0.00096			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 30 mg/4360 mg = 0,00688 g/g CM2: 210 mg/2960 mg = 0,0709 g/g (CM1+CM2)/2 = 0.0389 g/g (Stated as 30 mg Cobalt magnet Raw material input by CM1) (Stated as 210 mg Permanent magnet Raw material input by CM2) This is an average value and the figure is based on two answers.	Input	Refined resource	Co	0.0039			g	Technosphere	
	Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 600/4360 = 0,138 g/g (stated by CM1 as Polyurethane copper wire) This is not an average value and the figure is based on one answer. Notes: This flow actually refers to ''polyurethane copper wire''.	Input	Refined resource	Cu	0.14			g	Technosphere	
	Date concieved: 1999-04-23 Data type: Derived, unspecified Method: CM1: 1,9 Wh/4,36 g CM2: 680 Wh/2,96 g (stated as 0.68 kWh by CM2) ---> (CM1+CM2)/2 = 115,08 Wh /g relay This is an average value and the figure is based on two answers.	Input	Refined resource	Electricity	115			Wh	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM 1: 12/4360 g/g CM 2: 75/2960 g/g (CM1 + CM2)/2 = 0,014 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Epoxy	0.014			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM 1: 8/4360 = 0,00183 g/g (Stated as 8 mg Ethanol Raw material input by CM1) This is not an average value and the figure is based on one answer.	Input	Refined resource	Ethyl Alcohol	0.0018			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 2905/4360 = 0.66 g/g (stated as Pure iron by CM1) CM2: 1010/2960 = 0.34 g/g (stated as Core by CM2) (CM1+CM2)/2 = 0.5 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Fe	0.5			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM 1: 12/4360 = 0,00275 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Flux	0.0028			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 2/4360 = 0,000458 g/g (Stated as 2 mg Grease Raw material input by CM1) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Grease	0.00046			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1/4360 = 0,000229 g/g (Stated as 1 mg Hydrogen gas by CM1) This is not an average value and the	Input	Refined resource	Hydrogen	0.00023			g	Technosphere	

	figure is based only on one answer.									
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 12/4360 = 0,00275 g/g (Stated as 2-propanol by CM1) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Isopropanol	0.0028			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1080/4360 = 0,2477 g/g (Stated as LCP, liquid crystalline polymer) CM2: 4200/2960 = 1.419 g/g (CM1+CM2)/2 = 0.833 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Liquid crystal polymer (LCP)	0.83			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: Volume of nitrogen gas: 0,24 dm3 = 0,24e-3 m3 Density of nitrogen gas: 1,25 kg/m3 (ISBN 91-27-72174-4, page 72) (0,24e-3*1,25*1000)/4,36 g = 0,069 g/g (Stated as 0.24 litres of Nitrogen gas by CM1) This is not an average value and the figure is based only on one answer. Literature: ISBN 91-27-72174-4 page 71.	Input	Refined resource	N2	0.069			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 15/4360 = 0.00344 g/g (Stated as Nickel) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Ni	0.0034			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 81/4360 = 0,0186 g/g Higher Heating Value, HHV, for Oil is 45 MJ/kg, page 116 in ISBN 91-7548-544-3 0,0186e-3 * 45 = 8,37e-4 MJ/g (Stated as 81 mg Petroleum energy-are input by CM1) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Oil	0.00084			MJ	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 8/4360 = 0,00183 g/g (Stated as 8 mg Punching oil Raw material input by CM1) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Oil	0.0018			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 6433/4360 = 1,475 g/g CM2: 1580/2960 = 0.533 g/g (stated by CM2 as Copper alloy, enamelled copper wire) (CM1+CM2)/2 = 1.00 g/g This is an average value and the figure is based on two answers.	Input	Refined resource	Phosphorous bronze	1			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 400/4360 = 0,0917 g/g (stated by CM1 as Polyethylene sulfide) This is not an average value and the figure is based only on one answer. Notes: Poly(phenylene sulfide) [9016-75-5] Synonyms: Ryton; Phenylene Sulfide Resin; Poly(phenylene sulfide), powder;	Input	Refined resource	Polyphenyl sulphide	0.092			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 210/2960 = 0.071 g/g (Stated as Polyurethane) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Polyurethane	0.071			g	Technosphere	
	Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1/4360 = 0,000229 g/g (Stated by CM1 as Potassium cyanide) This is not an average value and the figure is based only on one answer. Notes: HTTP://chemfinder.camsoft.com /result.asp Potassium cyanide, CKN [CAS-number: 151-50-8 Synonyms: Hydrocyanic acid, potassium salt;	Input	Refined resource	Potassium cyanide	0.00023			g	Technosphere	

Molecule weight: 65.1077 g/mole									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 85/4360 = 0,0195 g/g This is not an average value and the figure is based only on one answer.	Input	Refined resource	Solder	0.019			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 9,85 J/4,36 g = 2,26 J/g (Stated as 9.85 J Steam energy-are input by CM1) This is not an average value and the figure is based only on one answer.	Input	Refined resource	Steam	2.3			kJ	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: This producer states they emit 124 mg per relay. One relay weigh 4,36 g. 124e-3/4.36 = 0,028 g/g Of the emissions to water the BOD fraction is 10 ppm. 0,028 * 10/1e6 = 2,84e-7 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	BOD	2.8E-07			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1 states they emit 2400 m3/h. That is 2400*365*24 = 21e6 m3/year and they produce 660 000 relays per year. 21e6/(600000*4,36) = 8,03 m3/g relay CO, CO2, NOx and SOX are 0,3 % chargeable to the above amount. 0,3/100 * 8,03 = 0,024 m3/g This volume is divided on CO2 11,5 %, NOx 150 ppm and SOx 0,0117 % (0,28 m3/h of 2400 m3/h). CO2: 0,115 * 0,024 m3/g = 2,76e-3 m3/g Density CO2: 1,98 kg/m3 (ISBN 91-27-72174-4, page 72) CO2: 2,76e-3*1,98 kg/m3 = 5,4648 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	CO2	5.5			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: This producer states they emit 124 mg per relay. One relay weigh 4,36 g. 124e-3/4.36 = 0,028 g/g Of the emissions to water the COD fraction is 24 ppm. 0,028 * 24/1e6 = 6,72e-7 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	COD	6.7E-07			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 8e-3/4,36 = 0,00183 g/g (Stated as Ethanol) This is not an average value and the figure is based only on one answer.	Output	Emission	Ethyl Alcohol	0.0018			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: This producer states they emit 124 mg per relay. One relay weighs 4,36 g. 124e-3/4.36 = 0,028 g/g Of the emissions to water the iron fraction is 0,19 ppm. 0,028 * 0,19/1e6 =5,32e-9 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Fe	5.3E-09			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 12e-3/4,36 = 0,00275 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Flux	0.0028			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: This producer states they emit 124 mg per relay. One relay weigh 4,36 g. 124e-3/4.36 = 0,028 g/g Of the emissions to water the heavy metal fraction is 0,05 ppm. 0,028 * 0,05/1e6 =1,4e-9 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Heavy metals	1.4E-09			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 12e-3/4,36 = 0,00275 g/g This is not an average value and the	Output	Emission	i-Propanol	0.0028			g	Air	

figure is based only on one answer.										
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: This producer states they emit 124 mg per relay. One relay weigh 4,36 g. 124e-3/4.36 = 0,028 g/g Of the emissions to water the sodium fraction is 3 ppm. 0,028 * 3/1e6 = 8,4e-8 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Na+	8.4E-08			g	Water		
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: This producer states they emit 124 mg per relay. One relay weigh 4,36 g. 124e-3/4.36 = 0,028 g/g Of the emissions to water the nitrates fraction is 20,05 ppm. 0,028 * 20,05/1e6 = 5,614e-5 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	Nitrates	0.000056			g	Water		
Date concieved: 1998 Data type: Derived, unspecified Method: CM1 states they emit 2400 m3/h. That is 2400*365*24 = 21e6 m3/year and they produce 660 000 relays per year. 21e6/(600000*4,36) = 8,03 m3/g relay CO, CO2, NOx and SOX are 0,3 % chargeable to the above amount. 0,3/100 * 8,03 = 0,024 m3/g This volume is divided on CO2 11,5 %, NOx 150 ppm and SOx 0,0117 % (0,28 m3/h of 2400 m3/h). NOx: 150/1e6 * 0,024 m3/g =3,6e-6 m3/g Density NO: 1,04 kg/m3 (http://www.chemfinder.com /cgi-win/cfserver.exe/, NOx approximated as NO, vapour density 1,04 kg/m3)) NO: 3,6e-6*1,04 kg/m3 = 3,744e-3 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	NOx	0.0037			g	Air		
Date concieved: 1998 Data type: Derived, unspecified Method: CM1 states they emit 2400 m3/h. That is 2400*365*24 = 21e6 m3/year and they produce 660 000 relays per year. 21e6/(600000*4,36) = 8,03 m3/g relay CO, CO2, NOx and SOX are 0,3 % chargeable to the above amount. 0,3/100 * 8,03 = 0,024 m3/g This volume is divided on CO2 11,5 %, NOx 150 ppm and SOx 0,0117 % (0,28 m3/h of 2400 m3/h). SOx: 0,0117/100 * 0,024 m3/g = 2,808e-6 m3/g Density SO2: 2,93 kg/m3 (ISBN 91-27-72174-4, page 72, SOx approximated as SO2) SO2: 2,808e-6*2,93 kg/m3 = 8,227e-3 g/g This is not an average value and the figure is based only on one answer.	Output	Emission	SOx	0.0082			g	Air		
Date concieved: 1998 Data type: Derived, unspecified Method: 1 gram relay output is the base for all figures in this model. Relays = Life Cycle Inventory model for production of one gram of relay (applicable to telecommunication equipment) (This model is based on two answers for surface mounted relays applicable to telecommunication equipment).	Output	Product	Relays	1			g	Technosphere		
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1/4360 = 0,000229 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Epoxy	0.00023			g	Technosphere		
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 1743/4360 = 0.4 g/g (stated as Pure iron by CM1) This is not an average value and the figure is based only on one answer.	Output	Residue	Fe	0.4			g	Technosphere		
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 540/4360 = 0,124 g/g This is not an average value and the	Output	Residue	Liquid crystal polymer (LCP)	0.124			g	Technosphere		

figure is based only on one answer.									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 4603/4360 = 1,055 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Phosphorous bronze	1.06			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 340/4360 = 0,078 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Polyphenyl sulphide	0.078			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 76/4360 = 0,0174 g/g This is not an average value and the figure is based only on one answer.	Output	Residue	Solder	0.017			g	Technosphere	

About Inventory

Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a relay manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of relays and resembling components in our telecom products. The usage for this set of data are life cycle assessments where relays are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly

	3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to relays intended for mounting on printed circuit boards in electronic equipment if you know how much the relays weigh. -- Transports. -- Here follows a more detailed description of transports of materials and components to the respective manufacturer factories. These transports are not included in the model. The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport. -- Truck transportation: -- CM1 = Component manufacturer one Weight of component: 4.36 g CM1: Liquid crystalline polymer with weight 1080 mg is transported 360 km + Polyethylene sulfide 400 * 360 + Pure iron 2905 * 360 + Phosphorous bronze 6433 * 400 + (sus316) 0,4 * 400 + AuAg alloy 4,2 *200 + cobalt magnet 30 *55 + epoxy resin 12 * 400 + Solder 85 * 450 + Flux 12* 450 + 2-propanol 12 * 360 + Punching oil 8 * 360 + Grease 2 * 360 + Potassium cyanide 1 * 360 + Ethanol 8 * 360 The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 4213.94 gkm/4,36 g = 966,5 gkm/g Component manufacturer two (CM2): Weight of component: 2.96 g Epoxy resin with weight 75 mg is transported 200 km, i.e. 75 mg*200 km + Permanent magnet 210 * 900 + Liquid crystalline polymer 4200 * 300 + Copper alloy 1580 * 300 + PUR enameled copper wire 0,21 * 400 + Mild steel 1,4 * 200 2299.92 gkm/2,96 g = 777 gkm/g This gives the average total transportation work by truck for CM1 and CM2: (CM1+CM2)/2 = 872 gkm/g relay

	This is an average value and the figure is based on two answers.
About Data	The data is based on information from two Japanese manufacturers. The information was gathered using a life cycle inventory questionnaire. All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model. Of the flows about little more than 85 % are not average values. The flows for Energy input of Electricity, Raw material input of Co, Epoxy resin, Fe, Liquid crystal polymer (LCP) and Phosphorous bronze are average values. In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included. The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. The result for CM2 is that approximately 90 % of the flows used in all manufacturers answers were only estimated, 3 % were only calculated, and 7 % of the flows were only measured.. The outline of the LCI data questionnaire that was used in the inventory follows below. No limitations or specifications were set for which substances they had to account -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes. Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gathered it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (E.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount (mg). Amount In Product (mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production sites (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Remelting of aluminium scrap

Administrative	
Finished	Y
Date Completed	2002-05-07
Copyright	EAA
Availability	Public

Technical System	
Name	Remelting of aluminium scrap
Functional Unit	1000 kg aluminium ingot
Functional Unit Explanation	Aluminium rolling or extrusion ingot.
Process Type	Gate to gate
Site	Not specified. See Geographical boundaries for further information.
Sector	Materials and components
Owner	Not specified. See Geographical boundaries for further information.
Technical system description	The inventory data cover remelting of aluminium process scrap, i.e. scrap generated internally, during the production of aluminium semi-finished products. The scrap input for aluminium remelting is clean scrap, i.e. excluding coated scrap, other contaminated scrap (through oil, dirt, etc.) and skimmings, which are processed via the aluminium refiners.

System Boundaries	
Nature Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- Cut-off criteria through out this inventory is basically relevance, as checked by the industry expert team monitoring the work and confirmed by reviewer I. Boustead. As a rough guideline ''less than 1% of total mass'' is applied for the inputs, i.e if the input is less than 1% of the total mass, then it is not included in the inventory table. The base for the choices of included inventory parameters is not further described in the EAA report.
Time Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- The data derived from an industry survey from 1998 and includes literature data from reports dated 1998 and 1999.
Geographical Boundary	--- BOUNDARIES VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- It is not always explicit in the report where the different included process steps take place. Data may be acquired from outside of Europe, e.g. regarding ancillary materials. See litterature references (LitteratureRef) next to the flow table (FlowMetaData) for further information about the data sources for each process step.
Other Boundaries	See Nature boundaries for a specification of the cut-off criteria that has been applied.
Allocations	Allocations are not explicitly specified in the Environmental Profile Report 2000.
Systems Expansions	System expansions are not explicitly specified in the Environmental Profile Report 2000.

Flow Data	
General Activity QMetaData	
Date Conceived	1998 - 1999
Data Type	Derived, unspecified
Represents	Not relevant.
Method	REMELTING OF ALUMINIUM SCRAP Data were obtained from aluminium-integrated cast house operations, i.e. cast houses associated with semi-finished aluminium production. The 1998 survey on semi-finished aluminium products also encompassed aluminium-integrated cast houses, with 37% coverage for the recycling of process scrap. TRANSPORTS Transport energy and air emission data have been taken from SAEFL Environmental Series 250

	(1998) ''BUWAL 250'', table 16.9 ELECTRICITY For all manufacturing operations, the consumption of fossil fuels and emissions linked to electricity production was calculated according to the UCTPE 94 electrical energy model as described in BUWAL 250. Emissions from combustion only, i.e. without the precombustion contribution, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of precombustion and combustion in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, inview of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors.
Literature Reference	---Recycling - Aluminium scrap terms and definitions: pr EN 12258-3 - Aluminium BREF note: document prepared for the EU Comission, 1999 ---Transport energy, electricity, and air emission - SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems.
Notes	In this inventory profile it is possible to identify if the emission derives from the process or the energy use, see Note-field for each specific flow.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Gas	83.7			Nm3	Ground	
Notes: 11,4 kg is alloying elements added in pure form and 10,4 kg is alloying elements added as master alloys.	Input	Refined resource	Alloying additives	21.8			kg	Technosphere	
Notes: Clean scrap, i.e. excluding coated scrap, other contaminated scrap (through oil, dirt, etc.) and skimmings, which are processed via the aluminium refiners.	Input	Refined resource	Aluminium scrap	1014			kg	Technosphere	
	Input	Refined resource	Ar-gas	1.5			m3	Technosphere	
	Input	Refined resource	Chlorine	0.012			m3	Technosphere	
	Input	Refined resource	Electricity	174			kWh	Technosphere	
	Input	Refined resource	Heavy fuel	1.7			kg	Technosphere	
	Input	Refined resource	Light fuel	0.078			kg	Technosphere	
	Input	Refined resource	Nitrogen	1.0			m3	Technosphere	
	Input	Refined resource	Refractory materials	1.4			kg	Technosphere	
	Input	Refined resource	Salt	0.89			kg	Technosphere	
Notes: Water is used for cooling.	Input	Refined resource	Water	78			m3	Technosphere	
Notes: Aluminium skimmings for recycling.	Output	By-product	Aluminium skimmings	32.7			kg	Technosphere	
Notes: This emission derives from the process Remelting of aluminium.	Output	Emission	Cl-	0.0039			kg	Air	
Notes: This emission derives from the fuel combustion and precombustion and the electricity production.	Output	Emission	CO	0.12			kg	Air	
Notes: This emission derives from the fuel combustion and precombustion and the electricity production.	Output	Emission	CO2	316			kg	Air	
Notes: This emission derives from the fuel combustion and precombustion and the electricity production.	Output	Emission	Dust	0.10			kg	Air	
Notes: This emission derives from the fuel combustion and precombustion and the electricity production.	Output	Emission	HC	0.96			kg	Air	
Notes: This emission derives from the process Remelting of aluminium.	Output	Emission	HCl	0.033			kg	Air	
Notes: This emission derives from the fuel combustion and precombustion and the electricity production.	Output	Emission	NOx	0.41			kg	Air	
Notes: This emission derives from the fuel combustion and precombustion and the electricity production.	Output	Emission	SO2	0.53			kg	Air	
	Output	Product	Aluminium ingot	1000			kg	Technosphere	

Notes: This residue derives from the rolled sheet production.	Output	Residue	Non hazardous waste	1.5			kg	Technosphere	

About Inventory

Publication	Environmental Profile Report for the European Aluminium Industry, European Aluminium Association, April 2000 -- Data documented by: Maria Erixon, IMI, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, IMI, Chalmers University of Technology Published in SPINE@CPM: 8 May 2002 --
Intended User	LCA-practitioners.
General Purpose	The European Aluminium Association (EAA) aims to contribute to further environmental improvements in aluminium products in a life cycle concept.
Detailed Purpose	The purpose with the Environmental Profile Report 2000 is to provide LCA-practitioners with detailed and up-to-date information representing the aluminium industry activities in Europe. The purposes with formatting the Environmental Profile Report 2000 for the European Aluminium Industry to the data documentation format SPINE, according to the data documentation criteria applied at Centre for environmental assessment of Product and Material systems (CPM) are: - CPM and European Aluminium Association (EAA) are anxious to provide life cycle assessment (LCA) practitioners with accurate and up to date environmental data for aluminium production. - EAA is interested in the SPINE formatting procedure and result, as the format is a base for (and therefor somewhat similar to) the new Technical Specification in ISO, ISO 14048, regarding LCA data documentation format. - EAA is interested in the CPM data quality control and documentation criteria.
Commissioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Practitioner	- EAA (European Aluminium Association) 12 Av. de Broqueville B-1150 Brussels .
Reviewer	Dr. Ian Boustead, - 2 Black Cottages West Grinstead, Horsham GB-West Sussex RH13 7BD
Applicability	--- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- RECOMMENDATIONS BY EAA WHEN USING THE DATA The data provided by the EAA members for their own process steps are the most up-to-date average data available for these processes, and it is recommended that they be used for LCA purposes. Older literature data should be disregarded, as it may no longer be representative due to technological improvements, progress in operating performance, changes with regard to raw materials or waste treatment, etc. To complete the product system inventory, data - on the production of consumer products, from semi-fabricated aluminium, - on the performance of consumer products in the use phase, and - on the recovery of scrap prior to remelting at the end of the product's useful life should be acquired. EAA recommend that these data be used in LCA studies in accordance with methodologies within the framework of the international standards in the ISO 14040-series. RELATED DATA SETS IN SPINE DATA FORMAT The data presented in the Environmental Profile Report is reformatted in to the SPINE format and structured according to the SPINE concept in as many separate activities (sub-systems) as possible. The system scope for the study as a whole is primary aluminium production, semi-finished aluminium production, and recycling. The SPINE formatting resulted in 7 activities. These activities are all published in the SPINE@CPM database. The production and recycling step are intended to be used together. For example, to obtain a cradle to gate-system for rolled aluminium sheet, the activity Primary aluminium production should be connected to the activity Production of rolled aluminium sheet. A recycling step (Aluminium recycling by refiners) could also be connected to such a system, depending on the scope. -- List of activities formatted in the SPINE-format, published in SPINE@CPM -- Primary aluminium production 1. Primary aluminium production

	Semi-finished aluminium product fabrication 2. Production of rolled aluminium sheet 3. Production of extruded aluminium profiles 4. Production of 0,02-0,2 mm single-rolled aluminium foil 5. Production of 0,005-0,02 mm double-rolled aluminium foil Recycling 6. Re-melting of aluminium scrap 7. Aluminium recycling by refiners Please note: The recycling process 6. Re-melting of aluminium scrap is included in the semi-finished aluminium product fabrication, i.e. activities 2-5. When designing a product system with the activities above where recycled aluminium is regarded, the activity Aluminium recycling by refiners should be used. The Re-melting of aluminium activity is only a specification if the user is specifically interested in this process step. RECYCLING RATES FOR ALUMINIUM PRODUCTS AFTER USE After use, aluminium products are a valuable re-usable resource. The European recycling rates for end products are currently around 95% for the automotive sector and 85% for the building sector. IMPROVEMENTS IN THE ENVIRONMENTAL PERFORMANCE OF ALUMINIUM PRODUCTS AND PROCESSES OVER THE PAST FEW YEARS Over the past few years EAA has achieved major improvements in the environmental performance of its production processes by means of the following: - improvement on existing technology - development and introduction of new technology and operations - increased recycling of all materials in the production process. Examples of major environmental improvements in aluminium products achieved over the past few years include: - weight reduction by downgauging in the packaging sector - energy savings through weight reduction and subsequent fuel reduction in the transport sector - reduction of maintenance in the building sector The previous Ecological Profile Report from EAA was published in 1996.
About Data	--- GENERAL INFORMATION VALID FOR ALL DATA SETS FROM THE ENVIRONMENTAL PROFILE REPORT 2000 --- PRECISION According to EAA, the environmental data figures in the inventory table are usually accurate to a precision of 5%. DATA SOURCES FOR FUELS/ENERGY PRODUCTION AND COMBUSTION The electricity supply systems and fuel production and use (transport energy and emission data) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250' and EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems. All emissions connected with total fuel consumption (i.e. production and combustion of oil, gas or coal) have been taken from SAEFL Environmental Series 250 (1998) 'Buwal 250', table 16.9. Emissions from combustion only, i.e. excluding the contribution of the production of the fuel, have been considered where appropriate in order to make a direct comparision with the corresponding process emissions. Emission data for combustion came from a report prepared by EMPA for EEA (13 December 1997), showing the respective contributions of production and combustion of fuels in 'BUWAL 250, table 16.9'. Although emissions from fuel combustion were often covered in the industry survey reporting, data calculated from BUWAL 250 were always used, in view of the fact that the survey results were not sufficiently reliable due to inconsistent use of conversion factors. REVIEW OUTSPOKE Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, April 2000, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. Ian Bousteds' review comments on the Environmental Profile Report for the European Aluminium Industry, April 2000: ''...I have received the detailed calculations on which this present environmental report is based. All of the queries that I raised after working through these reports were answered satisfactory.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Good-quality data were supplied by the EAA member companies, and the number of companies participating provides good coverage of the various processes, meaning that the results can be regarded as representative of the industryas a whole for the production of primary aluminium and subsequent conversion processes.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000 ''Because of the very fragmented nature of the recycling industry and wide variations in

	practices, it is recognised that the data presented for this sector of the industry can only be regarded as indicative. Nevertheless it is helpful to have such information from an authorative source.'' Ian Bousted, Environmental Profile Report for the European Aluminium Industry, April 2000
Notes	REVIEWER Ian Boustead has reviewed and commented on the Environmental Profile Report for the European Aluminium Industry, which is a revision of the first Ecological Profile Report from EAA that were published in 1996. See AboutData for review comments.

SPINE LCI dataset: Resistor for hole mounting assembly

Administrative	
Finished	Y
Date Completed	2000-02-18
Copyright	Ericsson
Availability	Official

Technical System	
Name	Resistor for hole mounting assembly
Functional Unit	One gram resistor intended for hole mounting
Functional Unit Explanation	The motivation for choosing this functional unit is: · suitable unit to work with in an LCA of a private branch exchange (a complicated telecom product) · important component of the MD110 product system and many other electronic products. DESIGN Both answers from component manufacturer one (CM1) and component manufacturer two (CM2) are for exactly the same component. These facts are based on Ericsson technical specification of the component. Ericsson product number: REP 264 Ericsson description: Metal film resistor General technical specification The resistor consists of a ceramic rod on which a vacuum evaporated metal film is on deposited. The terminals are of tinned copper. The resistor shall be coated with several layers of laquer, which provides electrical, mechanical and climate protection. Dimensions: resistor size 0207 Weight: about 0.3 grams Clean leads can be accepted. Diameter: 1.9 - 2.5 mm Terminal diameter: 0.57 - 0.63 mm Length of resistor body: 5.0 - 7.0 mm
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of a resistor intended for hole mounting. . The activity is an average based on information acquired from two manufacturers. The description of the process is supplied by manufacturer one, but is assumed to be general for this type of manufacture. The following process steps are included; 1. Incoming material

	2. Incoming inspection 3. Ceramic rods 4. Preparation of ceramic rods for deposition processes 5. Deposition material 6. Deposition of metal film 7. Ageing 8. Release test of deposited lots 9. Capping 10. Endcaps 11. Classifying according to R-value (not stated by this manufacturer, CM1, what R-value is. I suppose it is the resistor value of the resistor) 12. Intermediate stock 13. Laser sprialing 14. Release test of spiralled lots 15. Leads 16. Welding of leads 17. Welding strength test 18. Laquer, marking ink and taping material 19. 100 % electrical overload test, coating, marking, 100 % non-linearity ltest, 100% R value test, taping, visual inspection 20. Packaging material 21. Packaging and labelling 22. Lot release test. 23. Shipping department No detailed description was given by manufacturer one. Manufacturer two did not give any information about process steps.

System Boundaries	
Nature Boundary	Emissions to air, water and soil are excluded due to lack of data.
Time Boundary	1997 The answer from the manufacturer arrived in 1998 and they measured in 1997. The process technology used is most certainly the best available as the factories are located in western Germany and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturers included in the average are located in Germany.
Other Boundaries	Delimitations to the system is the final step in the making of the HMD resistor. The production of the subparts (e.g. ceramic, caps, leads and targets) of the resistor is not included in this model The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability. For component manufacturer one, the packaging materials for the incoming raw material have not been included.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory. Component manufacturer two (CM2) manufacture several models of resistors and found it impossible to allocate the energy-ware input to e.g. leaded resistors. The electricty consumption per component is well acertained by both manufacturers.
Systems Expansions	None.

Flow Data	
General Activity QMetaData	
Date Conceived	1997
Data Type	Derived, unspecified
Represents	Not relevant.
Method	The data that are presented are calculated as a average based on information from two component manufacturers. The information from the manufacturers were acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers'' In the information supplied by the capacitor manufacturers, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of

	material y in component material declaration, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+..+.ACn Step 2: The sum AC11+..+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to two answers was made.
Literature Reference	---Recycling - Aluminium scrap terms and definitions: pr EN 12258-3 - Aluminium BREF note: document prepared for the EU Comission, 1999 ---Transport energy, electricity, and air emission - SAEFL Environmental Series 250 (1998) ''BUWAL 250'', table 16.9 - EMPA report for EAA dated 27 April 1998, derived from Buwal 250 for national grid systems.
Notes	CM1 = component manufacturer one, factory located in Germany CM2 = component manufacturer two, factory located in Germany

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: Component weight: 0.227 g 35.36 mg / 227 mg = 0.155 g/g (Stated as Aluminiumoxide by CM1) CM2: Component weight: 0.219571 g 35.56 mg/ 219,571 mg = 0.161 g/g (CM1+CM2)/2 = 0.158 g/g	Input	Refined resource	Al2O3	0.16			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: Component weight: 0.227 g 0.2 mg / 227 mg = 0.00088 g/g CM2: Component weight: 0.219571 g 0.04 mg/ 219,571 mg = 0.00018 g/g (CM1+CM2)/2 = 0.00053 g/g	Input	Refined resource	Cr	0.00053			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: Component weight: 0.227 g 138.03 mg / 227 mg = 0.608 g/g CM2: Component weight: 0.219571 g 136.62 mg/ 219,571 mg = 0.622 g/g (CM1+CM2)/2 = 0.615 g/g	Input	Refined resource	Cu	0.62			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: Component weight: 0.219571 g 0.124 kJ/ 0.219571 g = 0.56 kJ/g The data is given per the total amount of resistors. It is not possible to separate the data only for leaded resistors. Notes: In the LCA project ''Life Cycle Assessment of MD110'' at Ericsson we used European average electricity for for this flow. German electricuty is the most suitable as the factories are located in Germany.	Input	Refined resource	Electricity	0.56			kJ	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: Component weight: 0.227 g 3.41 mg / 227 mg = 0.015 g/g	Input	Refined resource	Epoxy	0.015			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: Component weight: 0.227 g 28.7 mg / 227 mg = 0.126 g/g CM2: Component weight: 0.219571 g 27.66 mg/ 219,571 mg = 0.126 g/g (CM1+CM2)/2 = 0.126 g/g	Input	Refined resource	Fe	0.13			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: Component weight: 0.219571 g 1.84 mg/ 219,571 mg = 0.00837 g/g	Input	Refined resource	Glazeformer	0.0084			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: Component weight: 0.227 g 2.39 mg / 227 mg = 0.01 g/g	Input	Refined resource	Hardener	0.01			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: Component weight: 0.227 g 0.1 mg / 227 mg = 0.0044 g/g CM2: Component weight: 0.219571 g 0.54 mg/ 219,571 mg = 0.0025 g/g	Input	Refined resource	Ni	0.0034			g	Technosphere	

(CM1+CM2)/2 = 0.0034 g/g									
Date concieved: 1997 Data type: Derived, unspecified Method: CM2 states they use 98,7 mm3 oil for a component which weighs 219,571 mg. According to Produktekologi, Brohammer (ISBN 91-7548-544-3) page 116 HHV for oil is 45 MJ/kg. The density for oil is approximately 0,89 kg/dm3. 1 mm3 = 1e-6 dm3 98,7 mm3 oil weighs 98,7 e-6 *0,89 = 0,0878 g 0,0878 g / 0,219571 g = 0,4 g oil/g resistor 0,4 g e-3 * 45 MJ/kg = 0,018 MJ/g The data is given per the total amount of resistors. It is not possible to separate the data only for leaded resistors.	Input	Refined resource	Oil	0.018			MJ	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: Component weight: 0.219571 g 0.001 mg/ 219,571 mg = 4.55e-6 g/g	Input	Refined resource	Organic pigments	0.0000045			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: Component weight: 0.219571 g 0.06 mg/ 219,571 mg = 0.000273 g/g	Input	Refined resource	P	0.00027			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: Component weight: 0.227 g 1.71 mg / 227 mg = 0.00753 g/g	Input	Refined resource	Pb	0.0075			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: Component weight: 0.219571 g 1.75 mg/ 219,571 mg = 0.00797 g/g	Input	Refined resource	Polymethane resin	0.008			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: Component weight: 0.219571 g 0.28 mg/ 219,571 mg = 0.00127 g/g	Input	Refined resource	Resol resin	0.0013			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: Component weight: 0.227 g 6.24 mg / 227 mg = 0.027 g/g CM2: Component weight: 0.219571 g 5.61 mg/ 219,571 mg = 0.025 g/g (CM1+CM2)/2 = 0.026 g/g	Input	Refined resource	SiO2	0.026			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: Component weight: 0.227 g 2.56 mg / 227 mg = 0.011g CM2: Component weight: 0.219571 g 7.95 mg/ 219,571 mg = 0.036g (CM1+CM2)/2 = 0.0236 g/g	Input	Refined resource	Sn	0.024			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: Component weight: 0.219571 g 0.42 mg/ 219,571 mg = 0.00191 g/g	Input	Refined resource	Talcum	0.0019			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: Component weight: 0.219571 g 0.84 mg/ 219,571 mg = 0.00382 g/g	Input	Refined resource	TiO2	0.0038			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: Component weight: 0.219571 g 0.39 mg/ 219,571 mg = 0.00177 g/g	Input	Refined resource	Trace elements	0.0018			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 5.28 cm3 5.28 cm3 = 5.28e-3 dm3 Density water: 1 kg/dm3 5.28e-3 dm3 ---> 5.28 g Water 5.28 g/0.219571 g = 24.05 g/g The data is given per the total amount of resistors. It is not possible to separate the data only for leaded resistors.	Input	Refined resource	Water	24.05			g	Technosphere	

Date concieved: 1998 Data type: Derived, unspecified Method: 1 gram resistor output is the base for all figures in this model. Resistors, hole mounted = Life Cycle Inventory model for production of one gram of resistor intended for hole mounting (applicable to telecommunication equipment)	Output	Product	Resistor for hole mounting	1			g	Technosphere	

About Inventory	
Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a resistor manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of HMD resistors and resembling components in our telecom products. The usage for this set of data are life cycle assessments where resistors intended for hole mounting are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly

	6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to resistors intended for hole mounting in electronic equipment if you know how much the resistors weigh. The model is also intended to be representative for varistors and thermistors for hole mounting in electronic equipment. -- Transports.-- Here follows a more detailed description of transports of materials and components to the respective manufacturer factories. These transports are not included in the model. CM1 = Component manufacturer one The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport. -- Truck transportation: -- Component manufacturer one (CM1): Weight of component: 0.227 g Ceramics with weight 0.0416 g is transported 30 km by road i.e. 0,0416 g*30 km, Metal film 0.0003 g*148 km, Metal caps 0.0288 g*492 km, Cover 0.0058 g*700 km and Wire 0.1423 g*541 km. The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 96.5 gkm/0.227 g = 425.15 gkm/g Component manufacturer two (CM2): Weight of component: 0.219571 g Ceramics with weight 0.04184 g is transported 950 km by road i.e. 0,04184 g*950 km, Package 0.024 g*100 km, Metal caps 0.02837 g*300 km, Targets NiCr 0.0007 g*650 km and Lead wire 0.14457 g*550 km. The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives: 130.63 gkm/0.219571 g = 594.92 gkm/g This gives the average total transportation work by truck for CM1 and CM2: (CM1+CM2)/2= 510.04 gkm/g
About Data	The data is based on information from two German manufacturers. The information was gathered using a life cycle inventroy questionnaire. All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model.

	Of the flows about little more than 50 % are not average values.The flows for Raw material input of Al2O3, Cr, Cu, Epoxy resin, Fe, Ni, SiO2 and Sn are average values. In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included. The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so. 100 % of the flows stated by CM2 have been just measured. CM1 have not stated any information about the flows. The outline of the LCI data questionnaire that were used in the inventory follows below. No limitations or specifications were set for which substances they had to account -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes.´ Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gatherd it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Resistor for surface mounting assembly.

Administrative	
Finished	Y
Date Completed	2000-02-24
Copyright	Ericsson
Availability	Official

Technical System	
Name	Resistor for surface mounting assembly.
Functional Unit	One gram resistor intended for surface mounting
Functional Unit Explanation	The motivation for choosing this functional unit is: · suitable unit to work with in an LCA of a private branch exchange (a complicated telecom product) · important component of the MD110 product system and many other electronic products. DESIGN Both answers from component manufacturer one (CM1) and component manufacturer two CM2 are for exactly the same component. These facts are based on Ericsson technical specification of the component. Ericsson product number: REP 615 Ericsson description: Chip resistor General technical specification The resistor is intended for surface mounting and consists of a ceramic substrate where a resistor element is applied. The termination layer must contain a nickel barrier. Dimensions: resistor size 1206 Weight: about 9 milligrams (0.009 g) Length of resistor body: 3.2 mm Width: 1.6 mm Thickness: 0.55 mm
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of a resistor intended for surface mounting. The activity is an average based on information acquired from two manufacturers. The description of the process is supplied by manufacturer one, but is assumed to be general for this type of manufacture. The following process steps are included; 1. Incoming inspection 2. Bottom termination printing 3. Top termination printing 4.. Resistive body printing 5. Glass coat printing 6. Laser trimming 7. Protective coat printing 8. Substrate stripping 9. End termination forming 10. Chip break 11. Plating 12. Taping 13. Final inspection No detailed description was given by manufacturer one. Manufacturer two did not give any information about process steps. Recycling information: According to component manufacturer one (CM1), silver and palladium are recycled within the process:

	Silver: 21.26 mg/9.271 mg = 2.29 g/g product output. Palladium: 0.0013 mg/9.271 mg = 0.00014 g/g product output.

System Boundaries

Nature Boundary	The emissons to air have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impact has been studied. Included component manufacturers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used. Emissions to water are not included due to lack of data.
Time Boundary	1998 The answer from the manufacturer arrived in 1998 but none of them have specified when they measured. The process technology used is most certainly the best available as the factories are located in Japan and Israel respectively and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturers included in the average are located in Japan and Israel.
Other Boundaries	Delimitations to the system is the final step in the making of the SMD resistor. The production of the subparts (e.g. Substrate, Epoxy resin ink, Resistive ink, Termination ink and Glass ink) of the resistor is not included in this model The transportation of them to the factory is not included. For interested parties who wish to include the transport figures given from the manufacturers, can find the figures in the section Applicability. For component manufacturer two, the packaging materials for the incoming raw material have not been included.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Not relevant.
Method	The data that are presented are calculated as a average based on information from two component manufacturers. The information from the manufacturers was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers In the information supplied by the manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+..+.ACn Step 2: The sum AC11+..+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to two answers was made.
Literature Reference	
Notes	CM1 = component manufacturer one, factory located in Japan CM2 = component manufacturer two, factory located in Israel

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.181 mg/9.271 mg = 0.0195 g/g CM2: 0.1 mg/9 mg = 0.0111 g/g (CM1+CM2)/2 = 0.0153 g/g Notes: Cas-number 7440-22-4 according to HTTP://chemfinder.camsoft.com /result.asp	Input	Refined resource	Ag	0.015			g	Technosphere	

Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 9.871 mg/9.271 mg = 1.065 g/g (Stated as Alumina) CM2: 8.63 mg/9 mg = 0.9588 g/g (CM1+CM2)/2 = 1.0119 g/g Notes: Cas-number 1344-28-1 according to HTTP://chemfinder.camsoft.com /result.asp	Input	Refined resource	Al2O3	1.012			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: 0,89 Wh / 0,009271 = 95,99 Wh /g	Input	Refined resource	Electricity	95.99			Wh	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip resistor is 9,271 mg according to the producer. The producer states a use of epoxy resin of 0,096 mg. 0,096/9,271 = 0,01 g/g	Input	Refined resource	Epoxy	0.01			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip resistor is 9,271 mg according to the producer. The producer states a use of 0,011 mg. 0,011/9,271 = 0,0012 g/g Notes: Cas-number 9004-57-3 according to HTTP://chemfinder.camsoft.com /result.asp	Input	Refined resource	Ethyl Cellulose	0.0012			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,054 / 9,271 = 0,0058 g/g	Input	Refined resource	Lead borate	0.0058			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.413 mg/9.271 mg = 0.0445 g/g CM2: 0.2 mg/9 mg = 0.022 g/g (Stated as Nickel, Lead-Tin) (CM1+CM2)/2 = 0.033 g/g Notes: Cas-number 7440-02-0 according to HTTP://chemfinder.camsoft.com /result.asp	Input	Refined resource	Ni	0.033			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.053 mg/9.271 mg = 0.0057g/g Notes: Cas-number 7439-92-1 according to HTTP://chemfinder.camsoft.com /result.asp	Input	Refined resource	Pb	0.057			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.09 mg/9.271 mg = 0.0097 g/g	Input	Refined resource	PbO	0.0097			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0.04 mg/9 mg = 0.0044 g/g (stated as Polyimid resin)	Input	Refined resource	Polyimide	0.044			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Represents: The RuO2 flow from CM2 actually represents a metal film which also consists of MnO and CuO in unknown proportions between the three. Method: CM1: 0.18 mg/9.271 mg = 0.019 g/g CM2: 0.1 mg/9 mg = 0.011 g/g (CM1+CM2)/2 = 0.015 g/g	Input	Refined resource	RuO2	0.015			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,054 / 9,271 = 0,0058 g/g	Input	Refined resource	Se	0.0058			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: 0.27 mg/9 mg = 0.03 g/g Notes: CAS- number 99493-55-7	Input	Refined resource	Silicon oxide	0.03			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.054 mg/9.271 mg = 0.0058 g/g (stated as Silica) CM2: 0.05 mg/9 mg = 0.0056 g/g (CM1+CM2)/2 = 0.0057 g/g Notes: Silica is the same as Silicon(IV) oxide, i.e. SiO2, according to	Input	Refined resource	SiO2	0.0057			g	Technosphere	

HTTP://chemfinder.camsoft.com /result.asp									
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0.306 mg/9.271 mg = 0.033 g/g Notes: Cas-number 7440-31-5 according to HTTP://chemfinder.camsoft.com /result.asp	Input	Refined resource	Sn	0.033			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 0,097/9,271 = 0,01 g/g	Input	Refined resource	Solvent	0.01			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip resistor is 9,271 mg according to the producer. The producer states an emission to air of ethyl cellulose of 0,011 mg. 0,011/9,271 = 0,00119 g/g Notes: Cas-number 9004-57-3 according to HTTP://chemfinder.camsoft.com /result.asp	Output	Emission	Ethyl Cellulose	0.0012			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: The weight of the chip resistor is 9,271 mg according to the producer. The producer states an emission to air of solvent (unknown chemical composition) of 0,097 mg. 0,097/9,271 = 0,01 g/g	Output	Emission	Solvent	0.01			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: 1 gram resistor output is the base for all figures in this model. Resistors, surface mounted = Life Cycle Inventory model for production of one gram of resistor intended for surface mounting (applicable to telecommunication equipment)	Output	Product	Resistor for surface mounting	1			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: 1 gram resistor output is the base for all figures in this model. Resistor for surface mounting = Life Cycle Inventory model for production of one gram of resistor intended for surface mounting (applicable to telecommunication equipment)	Output	Residue	Al2O3	0.23			g	Technosphere	

About Inventory

Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the

	internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a resistor manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of SMD resistors and resembling components in our telecom products. The usage for this set of data are life cycle assessments where resistors intended for surface mounting are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to resistors intended for surface mounted resistors in electronic equipment if you know how much the resistors weigh. -- Transports.-- Here follows a more detailed description of transports of materials and components to the respective manufacturer factories. These transports are not included in the model. CM1 = Component manufacturer one The calculation for all modes of transport is done like this: First the total transportation work per functional unit is calculated for each included component manufacturer. Then the total transportation is summed and

divided by the number of included component manufacturers. This gives the average value for transportation by each mode of transport.

-- Truck transportation: --

Component manufacturer one (CM1):

Weight of component: 0.009271 g

Substrate with weight 0.008 g is transported 200 km by road i.e. 0.008 g*200 km, Epoxy resin ink 0.00014 g*300 km, Resistive ink 0.00011 g*300 km, Termination ink 0.0003 g*300 km and Glass ink 0.00011 g*300 km.

The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives:

1.798 gkm/0.009271 g = 193.93 gkm/g

Component manufacturer two (CM2):

Weight of component: 0.009 g

Ceramics with weight 0.0089 g is transported 30 km by road i.e. 0.0089 g*30 km, Stat. contact 0.0001 g*300 km, Metal film 0.0001 g*158 km, Glas cover 0.00005 g*380 km, Cover 0.00004 g*700 km and Lead wire 0.0002 g*300 km.

The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives:

0.4198 gkm/0.009 g = 46.64 gkm/g

This gives the average total transportation work by truck for CM1 and CM2:

(CM1+CM2)/2= 120.29 gkm/g

-- Boat transportation: --

Component manufacturer one (CM1):

Weight of component: 0.009271 g

Resistive ink 0.00011 g*300 km.

The total transportation work is calculated as follows: the weight of the materials and components multiplied by distance divided by the weight of the component. This gives:

0.033 gkm/0.009271 g = 3.56 gkm/g

About Data

The data is based on information from one Japanese manufacturer and one Israelic manufacturer. The information was gathered using a life cycle inventory questionnaire.

All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model.

Of the flows about little more than 73 % are not average values.The flows for Raw material input of Ag, Al_2O_3, Ni, RuO_2 and SiO_2 are average values.

In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included.

The figures in the original answer from the manufacturers should all have a special tag telling if the value has been calculated, measured or estimated or a combination of two or three of them. Ericsson specifically told the manufacturers to do so.

83 % of the flows stated by Component manufacturer one (CM1) and Component manufacturer two (CM2) have been just estimated. 8 % have been measured, 6 % have have no tag and 3 % are calculated.

The outline of the LCI data questionnaire that were used in the inventory follows below. No limitations or specifications were set for which substances they had to account

-- LCI data questionnaire --
Transport description:
Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km).

We here only asked for flows exceeded 2% by weight of the material declaration of the component.
Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes.´

Process description.

	Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gatherd it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Resistor network assembly

Administrative	
Finished	Y
Date Completed	2000-03-15
Copyright	Ericsson
Availability	Official

Technical System	
Name	Resistor network assembly
Functional Unit	One gram resistor network intended for hole mounting
Functional Unit Explanation	The motivation for choosing this functional unit is: · Suitable unit to work with in an LCA of a private branch exchanges (a complicated telecom product) · Important component of the MD110 product system and many other electronic products. Ericsson product number: RER 601 03/37 Ericsson description: Resistor network Single in line package (SIP), low profile, common terminal type. The resistor network consists of a ceramic substrate an 4, 5, 8, 9 or 10 thick film resistors of equal value, each connected to a common bus and a separate pin. Material

	Frame: Polyester Contacts: Phosphorous bronze Surface treatment: Contact area: 1.27e-6 m Au on 1.27e-6 m Ni. Soldering tags: 2e-6 m SnPb on 1.27e-6 m Ni. Dimensions: Height: 5.08 mm, Length: 12.7 mm, Width: 2.5 mm, Terminal thickness: 0.25 +/- 0.1 mm
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of a resistor network. Details on the production is not available. Note; This model is not based on information acquired from resistor network manufacturers. However, the electricity and oil use for the production has been approximated using information describing an other component; a hole mounted resistor.

System Boundaries

Nature Boundary	Emissions to air and water have been excluded due to lack of data.
Time Boundary	This model is intented to represent the assembly of resistor network in western Europe.
Geographical Boundary	This model is intended to represent the assembly of resistor networks in western Europe.
Other Boundaries	Delimitation's to the system is the final step in the making of the resistor network. The production of the subparts (e.g. frame, contacts and surface treatment) of the resistor network is not included in this model. The transportation of them to the factory is not included.
Allocations	Not relevant.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	Not relevant.
Method	Presented data for raw material input is based on a material declaration for a resistor network. Only amounts in product are presented, i.e. no waste is included. The electricity and oil use have been approximated using the average electricity use for production of hole mounted resistors. See Specific QMetaData for Electricty and Oil for a further description. Details on the production of hole mounted resistors can be found in the model ''hole mounted resistors production''.
Literature Reference	
Notes	The LCI model for HMD resistors has been taken as valid for resistor networks.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Ag	0.0035			g	Technosphere	
	Input	Refined resource	Al2O3	0.5098			g	Technosphere	
	Input	Refined resource	Cu	0.1961			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM2: Component weight: 0.219571 g 0.124 kJ/ 0.219571 g = 0.56 kJ/g The data is given per the total	Input	Refined resource	Electricity	0.157			Wh	Technosphere	

amount of resistors. It is not possible to separate the data only for leaded resistors.									
	Input	Refined resource	Epoxy	0.249			g	Technosphere	
	Input	Refined resource	Ni	0.0035			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: Used value: 0,016370496 MJ/g. Resistor manufacturer states they use 98,7 mm3 oil for a component which weighs 219,571 mg. According to ISBN 91-7548-544-3 page 116 HHV for oil is 45 MJ/kg. The density for oil is approximately 0,89 kg/dm3. 1 mm3 = 1e-6 dm3 98,7 mm3 oil weighs 98,7 e-6 *0,89 = 0,0878 g 0,0878 g / 0,219571 g = 0,4 g oil/g resistor 0,4 g e-3 * 45 MJ/kg = 0,018 MJ/g	Input	Refined resource	Oil	0.018			MJ	Technosphere	
Notes: Other is a abbreviation for the ceramics, plastics, metals or composites or other materials which are not defined. The supplier has not specified the chemical composition of the material used.	Input	Refined resource	Other	0.16			g	Technosphere	
	Input	Refined resource	Pb	0.0098			g	Technosphere	
	Input	Refined resource	PbO	0.0002			g	Technosphere	
	Input	Refined resource	Pd	0.0008			g	Technosphere	
	Input	Refined resource	RuO2	0.0016			g	Technosphere	
	Input	Refined resource	SiO2	0.0044			g	Technosphere	
	Input	Refined resource	Sn	0.0196			g	Technosphere	
Date concieved: 1999 Data type: Derived, unspecified Method: 1 gram resistor network output is the base for all figures in this model. LCI RNÄ = Life Cycle Inventory model for production of one gram of resistor network intended for hole mounting (applicable to telecommunication equipment)	Output	Product	Resistor networks	1			g	Technosphere	

About Inventory

Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems.

	Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a resistor network manufacturing/assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of resistor networks and resembling components in our telecom products. The usage for this set of data is life cycle assessments where resistor networks are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to resistor networks intended for mounting on PC-board in electronic equipment if you know how much the resistor networks weigh.
About Data	The value for electricity and oil use is approximated using information acquired from one manufacturer of a hole mounted resistor, described in the model ''Hole mounted resistor production''. The reason for this approximation is that we did not get any usable answer from resistor network manufacturers. Of all the eighteen models, resistor networks are most similar to the hole mounted resistors. The raw material input figures have their origin in material declaration of resistor networks developed at Ericsson. This means that only the amounts included in the product are presented. No waste is included.
Notes	

SPINE LCI dataset: Retapping of cooling medium in tanks

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Retapping of cooling medium in tanks
Functional Unit	ton
Functional Unit Explanation	1 ton freon (chlorofluorocarbons): 1,23% CFC, 46,9% HCFC and 51,9% HFC
Process Type	Gate to gate
Site	H Jessen Jurgensen AS Aröds Industriväg 70 422 43 Hisingsbacka Sweden
Sector	Waste treatment
Owner	H Jessen Jurgensen AS Aröds Industriväg 70 422 43 Hisingsbacka Sweden
Technical system description	The retapping of the cooling media (gas) is done in five steps: 1. HCFC22 and HFC134A are delivered in 20 ton transporting tanks and are tapped off into two 26 meters storing tanks. The rest of the gas is delivered in cylinders of the sizes 5, 10, 60 or 800 kg. 2. The retapping is done into tanks as above. The delivery amount is measured by weighing. 3. The gas reclaimed by the company is analysed gas cromatography. The one component gases CFC12, CFC502, HCFC22 and HFC134A are recycled as often as possible. When recycled the gas is filtered twice. 4. Reclaimed gas cylinders, brought to the company to be retapped, are cleansed by steam washing, when needed, after evacuated the cooling media. 5. Filled gas tanks are stored to be delivered to customers. The delivered tanks are protected by plastic shields.

System Boundaries	
Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1996
Data Type	Unspecified

Represents	Not relevant.
Method	Study of the Environmental report for 1996
Literature Reference	
Notes	The LCI model for HMD resistors has been taken as valid for resistor networks.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: 18,8% CFC is bought from ICI Norden and is retapped by H J Jurgensen AS. The rest is returned, used gas.	Input	Refined resource	CFC	29.08808697			kg	Technosphere	
Notes: A mixture of freons and other gases.	Input	Refined resource	Gas	29.41310651			kg	Technosphere	
Notes: 90,3% HCFC is bought and the rest is returned, used gas.	Input	Refined resource	HCFC	486.8245397			kg	Technosphere	
Notes: 94,6% HFC is bought and the rest is returned, used gas.	Input	Refined resource	HFC	544.093459			kg	Technosphere	
Notes: Waste when transfering the returned gas.	Output	Emission	Chlorofluorocarbon	0.163231754			kg	Air	
	Output	Product	CFC	12.32249			kg	Technosphere	
	Output	Product	HCFC	468.7378			kg	Technosphere	
	Output	Product	HFC	518.9398			kg	Technosphere	
Notes: Contains arkton /a mixture of contaminated, returned cooling medium, forwarding agent is Samtrans and receiver SAKAB Kumla.	Output	Residue	Hazardous waste	0.008847998			tonne	Technosphere	
Notes: Process water containing oil etc., forwarding agent is Reci Industri AB.	Output	Residue	Industrial waste	0.006487416			tonne	Technosphere	

About Inventory

Publication	Environmental report from H J Jurgensen AS for 1996, The Environmental Administration in the municipality of Göteborg. -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Olsson, Johan - H Jessen Jurgensen AS Aröds Industriväg 70 422 43 Hisingsbacka Sweden .
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	
About Data	
Notes	

SPINE LCI dataset: Rigid PUR foam

Administrative	
Finished	Y
Date Completed	1996
Copyright	
Availability	

Technical System	
Name	Rigid PUR foam
Functional Unit	1 kg of typical rigid PUR foam
Functional Unit Explanation	
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	This set of data does not concern the production of the polyurethane precursors (TDI, MDI, Polyols) but the production of one particular type of polyurethane foam. In fact, polyurethane foam can be rigid, flexible, etc. and then one can find different recipies for it (different mixing of the precursors). In fact, here is the recipe of the RIGID POLYURETHANE FOAM.

System Boundaries	
Nature Boundary	Air-, water emissions and wastes going out of our system Resource arriving into our system
Time Boundary	
Geographical Boundary	Europe
Other Boundaries	
Allocations	Unspecified
Systems Expansions	

Flow Data

General Activity QMetaData	
Date Conceived	98/01/26
Data Type	Unspecified
Represents	Not relevant.
Method	Normal LCI method for the production of rigid PUR foam (from the cradle to the gate)
Literature Reference	
Notes	The LCI model for HMD resistors has been taken as valid for resistor networks.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	1.5			MJ	Technosphere	Europe
	Input	Refined resource	MDI	0.616			kg	Technosphere	Europe
	Input	Refined resource	Pentane	0.054			kg	Technosphere	Europe
	Input	Refined resource	Polyether - polyols	0.386			kg	Technosphere	Europe
	Output	Emission	Pentane	0.003			kg	Air	Europe
	Output	Product	Rigid	1			kg	Technosphere	Europe
Notes: Waste foam	Output	Residue	Other rest products	0.02			kg	Technosphere	Europe

About Inventory

Publication	Eco profiles ot the European plastics industry Report 9 : Polyurethane precursors (TDI, MDI, Polyols) APME technical report June 1996 -- Data documented by: Sophie Louis, Volvo Technical Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	APME's eco-profiles serve two
General Purpose	There is an increasing demand concerning LCA data. Following this trend, ISOPA [The European Isocyanate Producers Association] members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of rigid PUR foam
Commissioner	- ISOPA, Avenue E. van Nieuwenhuyse 4 Box 2 B 1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	
About Data	Data on the production processes have been supplied by ARCO Chemical, BASF, BAYER, DOW, Enichem, ICI, Rhone Poulenc and Shell relating to plants operating in Belgium, France Germany, Italy, the Netherlands, Portugal, Spain and the United Kingdom. The transport of the different precursors is not included and must be added to the final inventory, depending on which distance is driven.
Notes	

SPINE LCI dataset: Ring processes at SKFs site in Göteborg

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Ring processes at SKFs site in Göteborg
Functional Unit	Steel rings, 858.5 kg.
Functional Unit Explanation	'Steel rings' includes one outer ring and one inner ring for SKF bearing 232/530 One SKF spherical roller bearing 232/530 consists of following components: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 rollers (coated or non-coated) The functional unit for this process is one inner ring 232/530 IR, 356 kg and one outer ring 232/530 OR, 387 kg.
Process Type	Gate to gate
Site	SKF Large Bearings
Sector	Materials and components
Owner	SKF Large Bearings

Technical system description	This activity describes a process step included in the system ''Production of bearing rings'', also available in the SPINE@CPM database. Ringprocesses at SKFs site in Göteborg is the last step in the production of bearing rings and the rings are processed into desired shape and quality. The hard treatment begins with grinding. Both sides on both rings are ground because of the need of reference surfaces when inspected with ultra sound. Additional material is turned off and the scrap is sent back to Ovako Steel AB, Sweden for recycling. After the turning the inner ring is polished and the outer ring is ground once again. This is the only difference between the two rings in the process at SKFs site in Göteborg. The jacket surface of the outer ring is spherically ground to be able to hold the rollers in place. In this step the outer ring also obtains its checked pattern on the inside, so that the lubricant can spread easily on the steel surface. The rings are now ready for assembling. Observe that this is only the last process step for the production of bearing rings. The complete environmental impact can be seen in ''Production of bearing rings'' in the SPINE@CPM database.

System Boundaries

Nature Boundary	Emissions to air is not measured and could therefore not be reported in this study. The steel scrap from the process at SKF, Göteborg is sent to Ovako Steel in Hofors for recycling and is therefore not seen as waste, but a co-product to the technosphere.
Time Boundary	The data was collected during the autumn 2002, and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The process is site specific for SKF in Göteborg, Sweden.
Other Boundaries	The electricity production is NOT included in this dataset but must be traced from its cradle. Internal transport 1 km with electric truck is included in the electricity consumption. BeTe Truck AB in Sweden has estimated the consumption of an electric truck: 0,75 kWh/km. The mineral oil in the cutting fluid (used at SKFs site in Göteborg) should be traced back to its cradle. The cutting fluid is an emulsion consisting of 4 % Castrol SW 3420. Castrol SW 3420 consists of 40% mineral oil according to the product data sheet (Castrol SW 3420). The amount of mineral oil must be accounted for to get the total environmental impact. The activities ''Extraction of crude oil'' and ''Refining of crude oil'' can be used from SPINE@CPM. The mineral oil in the emulsion should also be traced to its grave. It is separated from the water content and burnt in Halmstad and used as energy source for the cement industry. The activity ''Combustion of waste'' from SPINE@CPM database can be used.
Allocations	Energy consumption depends on how long the rings need to be processed in the processing equipment. This varies according to weight, but also according to size and desired properties of the final product. Allocations have been made according to weight and production
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	Not relevant.
Method	Data is gathered from interviews with Thomas Lundberg, SKF Large Bearings AB, Sweden.
Literature Reference	
Notes	The LCI model for HMD resistors has been taken as valid for resistor networks.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 02-08-01 - 02-12-31 Notes: The cutting fluid is an emulsion with 4 % CASTROL SW 3420. The Castrol SW3420 contains 40 % mineral oil. This amount of mineral oil should be accounted for and followed from the cradle.	Input	Refined resource	Cutting fluid	20			kg	Technosphere	Sweden

Date concieved: 02-08-01 - 02-12-31 Data type: Derived, mixed Method: Thomas Lundberg, the production manager at channel 23 at SKF Large Bearings in Göteborg, could only give the total energy consumption for all ring processing activities at SKF. This means that also the energy consumption from the activity ''turning of steel rings at SKFs site in Göteborg'' is included in this figure. Also internal transport, 1 km with electric truck, is included in the electricity consumption. BeTe Truck AB in Sweden made the assumption that the electricity consumption for an electric truck = 0,75 kWh/km.	Input	Refined resource	Electricity	255.75			kWh	Technosphere	Sweden
	Input	Refined resource	Steel ring	858.5			kg	Technosphere	Sweden
	Output	Co-product	Steel scrap	115.5			kg	Technosphere	Sweden
	Output	Product	Bearing rings	743			kg	Technosphere	Sweden
Date concieved: 02-08-01 - 02-12-31 Notes: The cutting fluid is an emulsion with 4 % CASTROL SW 3420. The Castrol SW3420 contains 40 % mineral oil. This amount of mineral oil should be accounted for and followed to the grave	Output	Residue	Cutting fluid	20			kg	Technosphere	Sweden

About Inventory	
Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	Much of the data is estimated specifically for the rings of these dimensions. The data should therefore be used carefully and can't be applied generally for ring processes.
About Data	Data is gathered from interviews with Thomas Lundberg, SKF Large Bearings AB, Sweden.
Notes	

SPINE LCI dataset: RME combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	RME combustion in heavy duty truck or bus, Euro V, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of RME to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from RME combustion in heavy duty truck or bus, Euro V, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	Not relevant.
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on ETC (transient test cycle for truck and bus engines), legislation limits for Euro V (2005/55/EC). The ETC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.44 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.
Literature Reference	Main references: (1) 2005/55/EC (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) Perstorp, Stefan Lundmark (5) EN 14214
Notes	The LCI model for HMD resistors has been taken as valid for resistor networks.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Product	Rapeseed methyl ester (RME)	1			MJ	Technosphere	

Method: Reference Perstorp. According to Stefan Lundmark, there are 1 fossil carbon for each C18 chain. The fossil carbon comes from the methanol. The carbon content is calculated = 1x12/(1x12+18x12) = 5.26 w-%. The heat value is 38.0 MJ/kg (Perstorp, product data sheet for RME). Recalculating to per MJ of fuel, 0.00508 kg of fossil CO2 per MJ is obtained (1 kg of C generates 3.67 kg of CO2). Literature: Perstorp, Stefan Lundmark	Output	Emission	Carbon dioxide (fossil)	0.00508			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Carbon monoxide	4.88888888888889E-04			kg	Air	
Method: 10% of THC according to JRC (2013). Literature: JRC (2013)	Output	Emission	Methane	6.72222222222222E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Nitrogen oxides	2.44444444444444E-04			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	6.11111111111111E-06			kg	Air	
Method: THC minus CH4. Literature: THC is from limit in Euro V legislation	Output	Emission	Non-methane volatile organic compounds	0.0000605			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro V legislation	Output	Emission	Particles (unspecified)	3.66666666666667E-06			kg	Air	
Method: The legislative limit is 10 mg/kg (10 ppm) (EN 14214), but here a typical value is chosen. 1 kg of S generates 2 kg of SO2. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 38.0 MJ/kg. Literature: Typical value	Output	Emission	Sulfur dioxide	1.57894736842105E-07			kg	Air	

About Inventory

Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	

Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: RME combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels

Administrative	
Finished	Y
Date Completed	2013-11-30
Copyright	f3 - Swedish Knowledge Centre for Renewable Transportation Fuels
Availability	Public

Technical System	
Name	RME combustion in heavy duty truck or bus, Euro VI, tank-to-wheel, f3 fuels
Functional Unit	1 MJ
Functional Unit Explanation	1 MJ input of RME to vehicle tank
Process Type	Gate to grave
Site	
Sector	Fuel
Owner	
Technical system description	The data represent emissions from RME combustion in heavy duty truck or bus, Euro V, tank-to-wheel. The emission legislation uses the definition of a heavy duty vehicle having a gross weight of 3.5 tons or more. The reported emission factors should be considered as generic data, and it should be noted that the emissions for a specific vehicle and a specific mission might differ from those generic data. For example, the limit values for certification of engines have been used as basis for deriving some of the emission factors. The duty cycles used for certification are defined to cover the whole range of typical loads of an engine in different operations. The operation of a specific vehicle can however differ from the duty cycle used in the certification, resulting in different emissions than calculated with the generic emission factors. E.g. for the regulated emissions: nitrous oxides, particles, total organic compounds and carbon monoxide, the values are conservative based on the maximum emissions limits per kWh of engine output when driving at the best point (the optimal engine speed/torque operating point). In reality, the values are often lower.

System Boundaries	
Nature Boundary	
Time Boundary	2010 - 2014
Geographical Boundary	Europe
Other Boundaries	
Allocations	No.
Systems Expansions	No.

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	Not relevant.
Method	The emission factors (EF, kg/MJ) for the regulated emissions have been estimated based on WHTC (World Harmonized Transient Cycle for truck and bus engines), legislation limits for Euro VI (Commission Regulation (EC) No 582/2011).The WHTC cycle is for heavy duty engines and vehicle (www.dieselnet.com). Equation for calculation of emission factors for fuel use: Efficiency: 0.44 (?)= (energy work/energy in fuel) which is the efficiency at the best point (the optimal engine speed/torque operating point) and which gives the maximum emission factors within the legislation limit. EF fuel use (g/MJ)=EF work (g/kWh)/3.6*? Emissions of CO2 and SO2 have been calculated based on carbon- and sulphur content in the fuel, see documentation "Data compilation method for a specific flow" and "Reference" in the Flow table. Emissions of CH4 was calculated from JRC (2013) and N2O was best estimate.
Literature Reference	Main references: (1) Commission Regulation (EC) No 582/2011 (2) www.dieselnet.com (3) JRC (2013) Tank-to-wheels, Report Version 4.0, JEC well -to-wheels analysis, well-to-wheels analysis of future automotive fuels and and powertrains in the European context, July 2013 (4) Perstorp, Stefan Lundmark (5) EN 14214
Notes	The LCI model for HMD resistors has been taken as valid for resistor networks.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Product	Rapeseed methyl ester (RME)	1			MJ	Technosphere	
Method: Reference Perstorp. According to Stefan Lundmark, there are 1 fossil carbon for each C18 chain. The fossil carbon comes from the methanol. The carbon content is calculated = 1x12/(1x12+18x12) = 5.26 w-%. The heat value is 38.0 MJ/kg (Perstorp, product data sheet for RME). Recalculating to per MJ of fuel, 0.00508 kg of fossil CO2 per MJ is obtained (1 kg of C generates 3.67 kg of CO2). Literature: Perstorp, Stefan Lundmark	Output	Emission	Carbon dioxide (fossil)	0.00508			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Carbon monoxide	4.88888888888889E-04			kg	Air	
Method: 10% of THC according to JRC (2013). Literature: JRC (2013)	Output	Emission	Methane	1.95555555555556E-06			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Nitrogen oxides	5.62222222222222E-05			kg	Air	
Method: Emissions of N2O are approximately 50 mg/kWh. This is a rough estimate based on limited data. Literature: Typical value Notes: The N2O emissions vary between different exhaust aftertreatment systems.	Output	Emission	Nitrous oxide	6.11111111111111E-06			kg	Air	

Method: THC minus CH4. Literature: THC is from limit in Euro VI legislation	Output	Emission	Non-methane volatile organic compounds	0.0000176			kg	Air	
Method: Regulated emission calculated according to: EF fuel use (g/MJ)=EF work (g/kWh) /3.6*? Literature: Limit in Euro VI legislation	Output	Emission	Particles (unspecified)	1.22222222222222E-06			kg	Air	
Method: The legislative limit is 10 mg/kg (10 ppm) (EN 14214), but here a typical value is chosen. 1 kg of S generates 2 kg of SO2. The heat value used for calculation to SO2 from per kg fuel to per MJ fuel was 38.0 MJ/kg. Literature: Typical value	Output	Emission	Sulfur dioxide	1.57894736842105E-07			kg	Air	

About Inventory	
Publication	Hallberg et al, (2013) "Setup of f3 data network for Well-to-wheel (method and) LCI data for fossil and renewable fuels in the Swedish market", f3 - Swedish Knowledge Centre for Renewable Transportation Fuels, f3 project report, Available at www.f3centre.se
Intended User	LCA practitioner
General Purpose	To provide and publish best available LCI data on vehicle biofuels and fossil fuels well to tank and tank to wheel relevant for the Swedish market.
Detailed Purpose	
Commissioner	- f3 - The Swedish Knowledge Centre for Renewable Transportation Fuels.
Practitioner	- Lisbeth Dahllöf (Volvo Group), Helen Mikaelsson (Scania).
Reviewer	- Lisa Hallberg, IVL
Applicability	
About Data	This dataset is the part of the results from the f3 project "Setup of f3 data network for Well-to-wheel (Method and) LCI data for fossil and renewable fuels in the Swedish market". Further details about this project can be found in the project report.
Notes	

SPINE LCI dataset: Roll-on-roll-off vessel (RoRo)

Administrative	
Finished	Y
Date Completed	1998 08
Copyright	NTM
Availability	Public

Technical System	
Name	Roll-on-roll-off vessel (RoRo)
Functional Unit	1 tonkm
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 50 % for tankers, 80 % for RoRo vessles and 60% for other vessles. This is concidered representative for traffic to/from Sweden. *empty trips are included.*

Process Type	Gate to gate
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation of Roll-on-roll-off vessel (RoRo), including vessels between 2000-30 000 dwt (deadweight tonnes), with an 80% utilisation level.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1999.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 50 % for tankers, 80% for RoRo vessles and 60% for other vessles 60% (including empty trips) *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1998 - 09
Data Type	Derived, unspecified
Represents	NTM
Method	For each individual ship, the load capacity (in dwt), installed engine effect (in kW) (Redareföreningen 1995) and speed (in knots) have been used as a basis. The emissions have been calculated on the basis of the distribution of low and high revolution engines among the different size classes, and the emission factors of the engines (Alexandersson et al 1991), see table below. The energy consumption has been calculated with the assumption of an oil consumption of 200 g/kWh for both low and medium revolution engines. The emisson factors below are given in g/kWh, where kWh refer to mechanical work done by the engine. Engine type Load NOx CO CO2 THC PM Low rev 80% 17,7 0,2 600 0,8 0,9 Medium rev 80% 14 1 620 0,2 0,4 The utilisation levels used in these calculations are as follows: Tank 0,5 Bulk 0,6 RoRo 0,8 LoLo 0,6 Ferry 0,6 Others 0,6 The calculations of emissions from shipping are made according to the following principle: emission factor = spec.emission x effect x 1 x 1 speed load capacity utilisation level The *quantity value* for all parameters is an average of all vessels in the population. The *minimum value* corresponds to the individual with the lowest energy use and emissions in the population, and the *maximum value* to the individual with the largest energy use and emissions in the population. The *utilisation level* with regard to weight is 80%, based on Demker et al.
Literature Reference	-Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Demker, G. et al. *Miljöeffekter av transportmedelsval för godstransporter*, MariTerm, KFB-rapport, 1994:6 *Skeppsregister 1995*, Swedish Shipowner Association Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 *Lloyds list*, 1996
Notes	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish

	Shipowners´ Association.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Input	Refined resource	Heavy oil	0.090	0.045	0.16	kWh	Technosphere	Sweden
	Output	Cargo	Cargo	1			tonne	Technosphere	Sweden
	Output	Emission	CO	0.0132	0.0040	0.0568	g	Air	Sweden
	Output	Emission	CO2	24.5	12.1	43.2	g	Air	Sweden
	Output	Emission	HC	0.029	0.016	0.040	g	Air	Sweden
	Output	Emission	NOx	0.66	0.35	1.22	g	Air	Sweden
	Output	Emission	Particles	0.0334	0.0177	0.0268	g	Air	Sweden
	Output	Emission	SO2	0.422	0.209	0.731	g	Air	Sweden

About Inventory

Publication	www.ntm.a.se Data documented by: Magnus Blinge, Dept. for Transportation & Logistics, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compile a set of data for the different traffic modes that are accepted by representatives for all traffic modes (air, rail, road and sea). In order to be able to make correct assessments, it is crucial to have knowledge of the different functions used for calculations, assumptions and environmental load of different modes of transportation. The ambition within NTM (Network for goods transportation and the environment) is to compile and document relevant environmental interventions associated with different transport systems, and to localise gaps of knowledge. The network is also intended to serve as a forum for discussion between different actors in the transport business. The members of NTM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology and the Swedish Society for Natural Conservation
Detailed Purpose	The first step in the work of NTM was to gather available data for energy use and emissions for the operation of different goods transport systems. The work is conducted in working group 1 of NTM, which consists of representatives from the organisations that are members of NTM. All work is based on voluntary contributions from the representatives. Data was obtained for energy use and emissions to air, both from the traffic systems and the energy supply systems (i.e. oil refining and electricity generation) The ambition was to present a span constructed by a ''low'', an average and a ''high'' value since the energy use and emissions to air in real traffic situations may vary greatly. These differences were calculated as differences in fuel and electricity consumption for the technology in use today. Where available, measurement data for regular traffic would be reported. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NTM.
Practitioner	Sörheim, Elisabet - Swedish Shipowners Association .
Reviewer	None, to be reviewed. -
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vessel, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association or from the operators. ***Type of vessels***

	Cargo Vessles - includes all vessels except RoRo vessels and ferries. Cargo Vessles thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc. Cargo Vessles are mainly used for transportation of heavy goods over large distances. The energy use for tankers is generally lower than for other Cargo vessles. *RoRo vessels* are used for transportation of different types of load carriers such as trailers, containers etc. The cargo is rolled on the vessel. RoRo vessels generally operate at a higher speed than regular Cargo vessles. *Ferries* carry both passengers and goods. The goods are carried in trucks, trailers or trains. ***Fuel*** The fuel quality vary to a large extent between different vessels. Smaller vessels that only operate on Swedish routes generally use cleaner fuels. The main part of freighters in Swedish traffic use heavy fuel oil, with a sulphur content of 2,6 %. Small coastal freighters may however use gas oil with sulphur content of 0,1 %. Gas oil is the most refined type of fuel used in vessels (the maximum sulphur content is 1,5 %). In ferries, low sulphur fuel with sulphur content of 0,5 % is generally used. ***Reduction of emissions*** The data does not assume the use of any emission reducing measures. Different measures may be taken to reduce the emissions, e.g. water injection may reduce the emissions of NOx by 50%, and adjustments of the engine may reduce NOx emissions by 30 %. Catalytic converters may reduce NOx emissions by 90-100% and HC by 70-80%. Emissions of particles and HC are also reduced. Installation of catalytic converters is however a large investment for the shipowners. There are at present only a few vessels in Swedish traffic that has installed catalytic converters. The other measures constitute a smaller investment, and it is anticipated that the shipowners will chose these techniques to reduce emissions. ***Bulky goods*** Vessels generally handle transportation of large heavy goods over long distances. Some bulky goods are however transported by sea, primarily by RoRo vessels and ferries. The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Travelled distance*** The travelled distance of the goods may be estimated using a Nautic almanac, Lloyd. Since the utilisation level includes empty trips, no compensation in the distance for empty trips needs to be done. ***International sea transports*** When using the data for international traffic, the sulphur emissions should be adjusted, since the fuel quality may vary. Representative sulphur content of fuel used in international traffic is 3,3 %. The energy use and emissions of other parameters may also vary to a large extent depending on the quality of the fuel. The utilisation levels used in these calculations are as follows: Tank 0,5 Bulk 0,6 RoRo 0,8 LoLo 0,6 Ferry 0,6 Others 0,6
About Data	Data have been calculated on the basis of the load capacity (in dwt), installed engine effect (in kW) (Redareföreningen) and speed (in knots) (Lloyds) of each individual ship. Emissions to air per tonkm have been calculated by using the emission factors of the engines (Alexandersson et.al. 1991), see table below, and by knowing the relation of low and medium revolution engines to different sizes of ships. The emisson factors below are given in g/kWh, where kWh refer to mechanical work done by the engine. Engine type Load NOx CO CO2 THC PM Low rev 80% 17,7 0,2 600 0,8 0,9 Medium rev 80% 14 1 620 0,2 0,4 The energy consumption has been calculated by the assumption of an oil consumption of 200g/kWh for both low and medium revolution engines. The sulphurous content of the fuel is assumed to be 2.6% for cargo-ships (Sjöbris 1994).
Notes	The person stated as ''Practitioner'' is the contact person for the data for transportation by boat in NTM. The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NTM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The major Swedish actors in the transportation business, which are members of NTM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives.

	The secretary for NTM is Anna Hadenius, TFK - Transport Research Institute, Stockholm.

SPINE LCI dataset: RoRo vessel, 2000-30000 dwt

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	RoRo vessel, 2000-30000 dwt
Functional Unit	1 tonkm, 80 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 80%. An utilisation level of 80% is representative for Swedish domestic traffic if *empty trips are included.*
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of Swedish flagged RoRo vessel, which are members of the Swedish shipowners´ Association. The loading capacity is 2000 - 30000 dwt (deadweight tonnes).

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated: CO2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents the fleet in 1997
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 80% (including empty trips). *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData	
Date Conceived	1990-01-01 - 1997-01-01
Data Type	Derived, unspecified
Represents	NTM
Method	The basis for the data are all Swedish flagged RoRo vessels between 2000 and 30000 deadweight tonnes, which are members of the Swedish Shipowners' Association. The *quantity value* for all parameters is an average of all vessels in the population. The *minimum value* corresponds to the individual with the lowest energy use and emissions in the population, and the *maximum value* to the individual with the largest energy use and emissions in the population. The *utilisation level* with regard to weight is 80%, based on Demker et al. The energy use and emissions per tonkm for each vessel was calculated (see Specific QMetaData for each flow). For each vessel, the loading capacity was stated in deadweight tonnes (Skeppsregister 1995), installed engine power in kW (Skeppsregister 1995) and speed in knots (Lloyds list). The share of two-stroke and four-stroke engines in each vessel was determined by the size of the vessel according to Alexandersson. All vessels in the population were then used to calculate an average value.
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Demker, G. et al. *Miljöeffekter av transportmedelsval för godstransporter*, MariTerm, KFB-rapport, 1994:6 *Skeppsregister 1995*, Swedish Shipowner Association Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 *Lloyds list*, 1996
Notes	Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The oil consumption per tonkm were calculated using assumptions on the oil consumption for two stroke and four stroke engines (g/kWh, where kWh refer to mechanical work done by the engine). The following *equation* was used to calculate the oil consumption per tonkm for each vessel: (oil consumption[g/kWh]*installed engine power[kW]*thermal value[MJ/kg])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** -Oil consumption: 200 g/kWh for both two-stroke and four-stroke engines (based on Alexandersson). -Thermal value for the oil: 40 MJ/kg. See General QMetaData for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18	Input	Refined resource	Heavy oil	0.33	0.16	0.56	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.0132	0.004	0.0568	g	Air	
Method: See QMetaData for NOx	Output	Emission	CO2	24	12	43	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.0287	0.0155	0.0404	g	Air	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm are calculated from standard values for the specific emissions for two-stroke and four stroke engines at 80 % engine load. The standard values are given in g/kWh, where kWh refer to mechanical work done by the engine. The following *equation* was used to calculate the emissions per	Output	Emission	NOx	0.66	0.35	1.2	g	Air	

tonkm for each vessel: (spec. emission factor[g/kWh]*engine power[kW])/(speed[km/h]*loading capacity[ton]*utilisation level) ***Data used in the calculations:*** *Specific emission factors:* The emission factors were given in Alexandersson and are based on measurements on the engine. Two stroke engines at 80 % engine load: -CO_2 600 g/kWh -NO_x 17,7 g/kWh -HC 0,8 g/kWh -CO 0,2 g/kWh -Particles 0,9 g/kWh Four stroke engines at 80 % engine load: -CO_2 620 g/kWh -NO_x 14 g/kWh -HC 0,2 g/kWh -CO 1 g/kWh -Particles 0,4 g/kWh See General QMetadata for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18									
Method: See QMetaData for NO_x	Output	Emission	Particles	0.0334	0.0177	0.0482	g	Air	
Date concieved: 1990-01-01 - 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the fuel. The following *equation* was used to calculate the emission for each vessel: 2*(oil consumption[g/kWh]*engine power[kW]* sulphur content)/(speed[km/h]*loading capacity[ton]*occupation) ***Data used in the calculations:*** -Sulphur content: 2,6 % (Sjöbris). -Oil consumption: 200 g/kWh for both two-stroke and four-stroke engines (Alexandersson). See General QMetaData for further details. Literature: Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 Sjöbris, A., Flodström, E. *Emissions och energivärderingsprinciper för transportsystem*, MariTerm, KFB-rapport 1994:9 Notes: The average sulphur content for oil used in international traffic is 3,3 %. (Alexandersson)	Output	Emission	SO_2	0.42	0.21	0.73	g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Elisabeth Sörheim, Swedish Shipowners' Association, contact person for sea transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen

Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Sörheim, Elisabeth - The Swedish Shipowners Association, Box 53046, S-400 14 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vessel, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. The data for RoRo vessels and ferries should be used with great care. The utilisation level on these types of vessels may vary greatly, depending on how the goods are packed. Both volume and weight limited goods may be transported. The data for ferries are especially sensitive, since the distribution between goods and passengers may vary to a large extent between different ferries. The Swedish Shipowners´ Association recommends that data for RoRo vessels should be used when considering transport by ferry. Vessels are individuals, which means that the energy use and emissions for different vessels at a given size may vary greatly. The vessels are generally optimised for the shipping route on which it will operate and the cargo it will carry. Generally, smaller vessels in Swedish traffic operate shorter routes, while larger vessels are used for transports to the continent and transocean transports. Data for the individual vessel performing the transport should be used when possible. Data for Swedish flagged vessels that are members of the Swedish Shipowners´ Association may be obtained from Elisabeth Sörheim at the Swedish Shipowners´ Association. ***Type of vessels*** *Freighters* - includes all vessels except RoRo vessels and ferries. Freighters thus include a large variety of different vessels; tankers, container ships, LoLo vessels, bulk vessels, vessels built for a special route etc. Freighters are mainly used for transportation of heavy goods over large distances. The energy use for tankers is generally lower than for other freighters. *RoRo vessels* are used for transportation of different types of load carriers such as trailers, containers etc. The cargo is rolled on the vessel. RoRo vessels generally operate at a higher speed than regular freighters. *Ferries* carry both passengers and goods. The goods are carried in trucks or trains. ***Fuel*** The fuel quality may vary to a large extent between different vessels. Smaller vessels that only operate on Swedish routes generally use better fuels. The main part of freighters in Swedish traffic use heavy fuel oil, with a sulphur content of 2,6 %. Small coastal freighters may however use gas oil with sulphur content of 0,1 %. Gas oil is the most refined type of fuel used in vessels (the maximum sulphur content is 1,5 %). In ferries, low sulphur fuel with sulphur content of 0,5 % is generally used. Differentiated harbour dues on sulphur and NOx emissions were introduced in Sweden 1 January 1998. This will probably result in use of fuels of a better quality, primarily in ferries but also other freighters. ***Reduction of emissions*** The data does not assume the use of any emission reducing measures. Different measures may be taken to reduce the emissions, e.g. water injection may reduce the emissions of NOx by 50%, and adjustments of the engine may reduce NOx emissions by 30 %. Catalytic converters may reduce NOx emissions by 90-100% and HC by 70-80%. Emissions of particles and HC are also reduced. Installation of catalytic converters is however a large investment for the shipowners. There are at present only a few vessels in Swedish traffic that has installed catalytic converters. The other measures constitute a smaller investment, and it is anticipated that the shipowners will chose these techniques to reduce emissions. ***Bulky goods*** Vessels generally handle transportation of large heavy goods over long distances. Some bulky goods are however transported by sea, primarily by RoRo vessels and ferries. The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Travelled distance*** The travelled distance of the goods may be estimated using a Nautic almanac, Lloyd. Since the utilisation level includes empty trips, no compensation in the distance for empty trips needs to be done. ***International sea transports***

	When using the data for international traffic, the sulphur emissions should be adjusted, since the fuel quality may vary. Representative sulphur content of fuel used in international traffic is 3,3 %. The energy use and emissions of other parameters may also vary to a large extent depending on the quality of the fuel.
About Data	The data for emissions is derived from specific emission factors for the engine at a constant 80 % engine load. No test cycle was used to obtain the emission factors. There is however a small need for test cycles, since vessels generally operate at constant load on the engine during the sail. The fact that the engine load sometimes is lower than 80 % i.e. when sailing to and from the harbour has been neglected. This part is generally small but complicated. The calculation model may be used to calculate the energy use and emissions for a specific vessel if the loading capacity, installed engine power etc. is known. This information may be obtained from Skeppsregister. See QMetaData for details.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: RoRo vessel, 2000-30000 dwt, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	RoRo vessel, 2000-30000 dwt, future
Functional Unit	1 tonkm, 80 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 80%. An utilisation level of 80% is representative for Swedish domestic traffic if *empty trips are included.*
Process Type	Unit operation
Site	Sweden
Sector	Sea transport
Owner	Sweden
Technical system description	Operation i.e. propulsion of Swedish flagged RoRo vessel with new technology reducing the energy use and emissions (catalytic converters, energy saving measures etc.). Only members of the Swedish Shipowners´ Association are included. The loading capacity is 2000 - 30000 dwt (deadweight tonnes).

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO-fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water (e.g. discharges of oil) and emissions to ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents new technology, available today but not yet in use.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 80% (including empty trips). *Parameters not considered* -Driving technique -External conditions e.g. climate etc. -Maintenance level of the vessel *Excluded subsystems* -Precombustion, i.e. production and distribution of the fuel. -Maintenance of the vessel (e.g. use of anti fouling) -After-treatment of the vessel -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	
Method	The energy use and emissions was calculated using *assumptions* on energy saving and emission reducing actions together with data for existing individual vessels with the *lowest energy use and emissions* within the population of Swedish flagged RoRo vessels with loading capacity 2000-30000 tonnes, which are members of the Swedish Shipowners' Association vessels. The utilisation level with regard to weight is 80 %. The assumptions were given by the Swedish Shipowners' Association. The data for energy use and emissions for the vessels that was the basis for the calculation, and a description on how the data was obtained, can be found in the activity with ObjectOfStudy.Name: *RoRo vessel, 2000-30000 dwt* (in this database) or in ''Energi- och emissionsuppgifter för godstransporter''. The minimum value for the energy use and emissions was used in the calculation. The following percentages for the reduction of energy use and emissions was used in the calculation: -Oil

	consumption: 30 % (by different energy saving measures) -NOx: 93 % (through optimisation of the engine and catalytic converters) -HC: 88 % (by catalytic converters) -CO: 81 % (by catalytic converters) -Particles: 35 % The sulphur content in the fuel was assumed to be 0,09 %. Emissions of SO2 were calculated from the fuel consumption using the sulphur content in the fuel. Emissions of CO2 were calculated from the fuel consumption using the carbon content in the fuel.
Literature Reference	Energi- och emissionsuppgifter för godstransporter i Sverige, Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning 1997, NGM- Nätverket för Godstransporter och Miljön.
Notes	

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Cargo	1			tonne	Technosphere	
	Input	Refined resource	Oil	0.11			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
	Output	Emission	CO	0.0008			g	Air	
	Output	Emission	CO2	8.4			g	Air	
	Output	Emission	HC	0.0019			g	Air	
	Output	Emission	NOx	0.012			g	Air	
	Output	Emission	Particles	0.0115			g	Air	
	Output	Emission	SO2	0.0072			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Elisabeth Sörheim, Swedish Shipowners' Association, contact person for sea transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Sörheim, Elisabeth - The Swedish Shipowners Association, Box 53046, S-400 14 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions for Swedish flagged RoRo vessels. The data represents new technology (catalytic converters, energy saving measures etc), not yet in regular use. There are at present only a few vessels in Swedish traffic that has installed catalytic converters, since installation of catalytic converters is a large investment for the shipowners.
About Data	The data is based on assumptions on different energy saving and emission reducing actions together with data for existing vessels in Swedish traffic with the lowest energy use and emissions. The data was compiled by the Swedish Shipowners´ Association. See Flow QMetaData for further information.

Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Sand extraction and processing. ESA-DBP

Administrative	
Finished	Y
Date Completed	1996
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Sand extraction and processing. ESA-DBP
Functional Unit	1 kg of sand
Functional Unit Explanation	Unknown
Process Type	Gate to gate
Site	Unknown
Sector	Biological
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''The sand is repeatedly washed, dried and sieved after it is obtained from its source. (...) Reclaimed sand - the sand which is reclaimed inside the foundry is cleaned in a washer before it is used again. The emissions from the washer are unknown, but assumed to be negliglible. Bagged sand - the sand which is very dirty is separated and packed in plastic covers. The sand is picked up by a waste company which takes it to a special landfill. Loose sand - sand which is not considered as very dirty but still too dirty to be reclaimed is picked up by a waste company. The waste company takes it to an ordinary landfill.'' This process is included in the system described in: Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Coal mining and cleaning. ESA-DBP - Cast iron production. ESA-DBP - Limestone quarrying. ESA-DBP - Sinter plant's process ESA-DBP - Uranium ore extraction and enrichment. ESA-DBP - Production of pig iron - blast furnace process. ESA-DBP

System Boundaries	
Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) and waste water generation.
Time Boundary	1994
Geographical Boundary	Unknown
Other Boundaries	Unknown
Allocations	Unknown

Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1994
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other report.
Literature Reference	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Data for particular process come from: Landbank Environmental Research & Consulting (1994), The Phosphate Report, Landbank
Notes	

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Raw sand	1.00E+00			kg	Ground	Not known
	Input	Refined resource	Electricity	6.00E-02			MJ	Technosphere	Not known
	Input	Refined resource	Heat	1.11E+00			MJ	Technosphere	Not known
	Input	Resource	Process water	4.00E+00			kg	Water	Not known
	Output	Product	Sand	1.00E+00			kg	Technosphere	Not known
	Output	Residue	Waste water	4.00E+00			kg	Technosphere	Not known

About Inventory	
Publication	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The aim of the study is to undertake an LCA of typical water and sewage pumps. Those aspects which have a major contribution to the environmental impact in the life cycle of a pump will be identified.''
Detailed Purpose	Sand is used in foundry manufacturing process tha is why it has to be investigated.
Commissioner	Unknown - .
Practitioner	Johanna Thuresson - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Sausage (Hot-Dog) production. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Sausage (Hot-Dog) production. ESA-DBP
Functional Unit	100 kg of 'Hot Dog'
Functional Unit Explanation	The average proteing content of the meat ingridients is 17,5%
Process Type	Gate to gate
Site	Swedish Meats, Örebro, Sweden
Sector	Crop and animal production, hunting etc.
Owner	Swedish Meats, Örebro, Sweden
Technical system description	Excerpt from the report, see 'Function': ''Sausages are common food in many countries, with a history that dates far back. In the beginning it was a way to preserve meat for a long time, and also to use the parts of the animal that could not be used as whole meat. (...) In co-operation with Swedish Meats, a production facility in Örebro, Sweden, was studied. The reason for choosing the particular facility was that it mainly produces one product, named Hot Dogs. (...) The main production process consists of eight processes, of which some may be divided into two or more steps: (...) 1. Grinding - Frozen products are thawed before use. The meat ingredients are ground, and an automatic device is used to supervise the fat content. 2. Pre-mixing - the meat mixture is mixed with water, ice, and salt. 3. Ripening in silo - storage of meat mixture, usually for 1-5 days. Six silos, each with a capacity of 12 tonnes. 4. Recipe mixing - mixing of meat mixture with other ingredients, such as potato starch and spices. A highly automated process, where the operator just defines the amounts, after which the mixture is prepared by the machine. 5. Extruding - four extruding machines, which are loaded with cellulose tubes. The sausage batter is extruded through the tubes at high speed, whereupon casing-covered sausages are formed. The cellulose casing is manufactured by Viscofan SA in Pamplona, Spain. Long strings of sausages are then cooked, smoked and cooled down. 6. Peeling of sausage strings - four parallel machines use steam to peel the casing off the sausages. 7. Packaging - six packaging lines with various capacity, each including several steps: positioning, vacuum packaging (big rolls of plastic wrapping are heat-moulded into shape, sausages are inserted, and the packages are sealed), scale/metal detector, (defective products are removed), picker (a fast robot loads the packages into plastic trays), robot loading trays on pallet. 8. Loading area - facility office; stock input to logistics software, and back-reporting of customer orders. The aim of this study has been to model real and present conditions. However, the manufacturers were not able to share their recipes and therefore the following recipes were used in this study: - Hot Dog, based on an estimate of the real recipe. - Pea Dog, a hypothetical product based on the Hot Dog recipe, but with 10% of the animal protein substituted for pea protein. - Soy Dog, a hypothetical recipe based on the contents and nutritional value of Dafgård's soy sausage, with a protein content of about 7%.'' This process is included in the system described in: Abelmann A. (2010). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Pea-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Pea cultivation. ESA-DBP - Production of beef. ESA-DBP - Production of pork. ESA-DBP - Rape seed cultivation. ESA-DBP - Wheat cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean processing. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries	
Nature Boundary	Refined and natural resources as well as the energy use are included in the study.
Time Boundary	Excerpt from the report, see 'Publication': ''The goal has been to use as present data as possible. Most data on the Örebro facility is based on actual numbers from 2004.''
Geographical Boundary	The study was done for Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': ''In order to simplify the recipe, different pork products have been aggregated into ''pork'', and beef products have in the same way been aggregated into ''beef''. In a real product, also ingredients such as ascorbic acid, lactate and acetate have to be added because of their function as preservatives and such; but as they usually make up very small shares of the product, they have been omitted from the recipe. (...) Not included are any aspects regarding personnel.''

Allocations	No information about the allocation in the report.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The recipes were modelled in the software and the energy use was adapted from the other report
Literature Reference	This process is included in the system described in: Abelmann A. (2010). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf
Notes	NB: The data were compiled from 2 tables: recipe and energy use. In a real product, also ingridients such as ascorbic acid, lactate and acetate have to be added because of their function as perservatives and such.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Input Product	Beef	3.90E+00			kg	Other	Sweden
	Input	Input Product	Pork	4.95E+01			kg	Other	Sweden
Notes: For peeling	Input	Refined resource	Biogas	2.70E+02			MJ	Technosphere	Sweden
	Input	Refined resource	District heating	4.30E+01			MJ	Technosphere	Sweden
Notes: 0,05 MJ for grinding; 0,05 MJ for pre-mixing; 0,20 MJ for recipe mixing; 0,12 MJ for extruding; 0,12 MJ for conveyor; 0,086 MJ for peeling; 0,13 MJ for packaging and for the general use 1,22 MJ	Input	Refined resource	Electricity	1.98E+02			MJ	Technosphere	Sweden
Notes: For peeling	Input	Refined resource	Heat oil	1.28E+01			MJ	Technosphere	Sweden
Notes: Nitrite salt is sodium chloride with a nitrite content of 0,5% and is included to impedes on the growth of the bacteria Clostridium Botulinum. About a third is left in the product after processing.	Input	Refined resource	Nitrite salt	1.80E+00			kg	Ground	Sweden
	Input	Refined resource	Potato starch	1.00E+01			kg	Ground	Sweden
Notes: Water is added twice during the production process. 4kg of water are lost during the production process	Input	Resource	Water	3.05E+01			kg	Water	Sweden
	Input	Resource	Water	3.80E+00			kg	Water	Sweden
	Output	Product	Sausage Hot - Dog	1.00E+02			kg	Other	Sweden

About Inventory

Publication	Abelmann A. (2010). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .
Practitioner	Anders Abelmann - Chalmers University of Technology.

Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Sausage (Pea-Dog) production. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Sausage (Pea-Dog) production. ESA-DBP
Functional Unit	100 kg of 'Pea Dog'
Functional Unit Explanation	The average proteing content of the meat ingridients is 17,5%
Process Type	Gate to gate
Site	Swedish Meats, Örebro, Sweden
Sector	Food products and beverages
Owner	Swedish Meats, Örebro, Sweden
Technical system description	Excerpt from the report, see 'Function': ''Sausages are common food in many countries, with a history that dates far back. In the beginning it was a way to preserve meat for a long time, and also to use the parts of the animal that could not be used as whole meat. (...) In co-operation with Swedish Meats, a production facility in Örebro, Sweden, was studied. The reason for choosing the particular facility was that it mainly produces one product, named Hot Dogs. (...) The main production process consists of eight processes, of which some may be divided into two or more steps: (...) 1. Grinding - Frozen products are thawed before use. The meat ingredients are ground, and an automatic device is used to supervise the fat content. 2. Pre-mixing - the meat mixture is mixed with water, ice, and salt. 3. Ripening in silo - storage of meat mixture, usually for 1-5 days. Six silos, each with a capacity of 12 tonnes. 4. Recipe mixing - mixing of meat mixture with other ingredients, such as potato starch and spices. A highly automated process, where the operator just defines the amounts, after which the mixture is prepared by the machine. 5. Extruding - four extruding machines, which are loaded with cellulose tubes. The sausage batter is extruded through the tubes at high speed, whereupon casing-covered sausages are formed. The cellulose casing is manufactured by Viscofan SA in Pamplona, Spain. Long strings of sausages are then cooked, smoked and cooled down. 6. Peeling of sausage strings - four parallel machines use steam to peel the casing off the sausages. 7. Packaging - six packaging lines with various capacity, each including several steps: positioning, vacuum packaging (big rolls of plastic wrapping are heat-moulded into shape, sausages are inserted, and the packages are sealed), scale/metal detector, (defective products are removed), picker (a fast robot loads the packages into plastic trays), robot loading trays on pallet. 8. Loading area - facility office; stock input to logistics software, and back-reporting of customer orders. The aim of this study has been to model real and present conditions. However, the manufacturers were not able to share their recipes and therefore the following recipes were used in this study: - Hot Dog, based on an estimate of the real recipe. - Pea Dog, a hypothetical product based on the Hot Dog recipe, but with 10% of the animal protein substituted for pea protein. - Soy Dog, a hypothetical recipe based on the contents and nutritional value of Dafgård's

	soy sausage, with a protein content of about 7%.'' This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Pea cultivation. ESA-DBP - Production of beef. ESA-DBP - Production of pork. ESA-DBP - Rape seed cultivation. ESA-DBP - Wheat cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean processing. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries

Nature Boundary	Refined and natural resources as well as the energy use are included in the study.
Time Boundary	Excerpt from the report, see 'Publication': ''The goal has been to use as present data as possible. Most data on the Örebro facility is based on actual numbers from 2004.''
Geographical Boundary	The study was done for Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': ''In order to simplify the recipe, different pork products have been aggregated into ''pork'', and beef products have in the same way been aggregated into ''beef''. In a real product, also ingredients such as ascorbic acid, lactate and acetate have to be added because of their function as preservatives and such; but as they usually make up very small shares of the product, they have been omitted from the recipe. (...) Not included are any aspects regarding personnel.''
Allocations	No information about the allocation in the report.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The recipes were modelled in the software and the energy use was adapted from the other report
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf
Notes	NB: The data were compiled from 2 tables: recipe and energy use. In a real product, also ingridients such as ascorbic acid, lactate and acetate have to be added because of their function as perservatives and such.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Input Product	Beef	4.10E+00			kg	Other	Sweden
	Input	Input Product	Pork	4.55E+01			kg	Other	Sweden
Notes: Water is added twice during the production process. 4kg of water are lost during the production process	Input	Natural resource	Water	3.22E+01			kg	Water	Sweden
	Input	Natural resource	Water	4.00E+00			kg	Water	Sweden
Notes: For peeling	Input	Refined resource	Biogas	2.79E+02			MJ	Technosphere	Sweden
	Input	Refined resource	District heating	4.30E+01			MJ	Technosphere	Sweden
Notes: 0,05 MJ for grinding; 0,05 MJ for pre-mixing; 0,20 MJ for recipe mixing; 0,12 MJ for extruding; 0,12 MJ for conveyor; 0,086 MJ for peeling; 0,13 MJ for packaging and for the general use 1,22 MJ	Input	Refined resource	Electricity	1.98E+02			MJ	Technosphere	Sweden
Notes: For peeling	Input	Refined resource	Heat oil	1.28E+01			MJ	Technosphere	Sweden

Notes: Nitrite salt is sodium chloride with a nitrite content of 0,5% and is included to impedes on the growth of the bacteria Clostridium Botulinum. About a third is left in the product after processing.	Input	Refined resource	Nitrite salt	1.90E+00			kg	Ground	Sweden
	Input	Refined resource	Pea protein	1.00E+00			kg	Other	Sweden
	Input	Refined resource	Potato starch	1.05E+01			kg	Ground	Sweden
	Output	Product	Sausage Pea - Dog	1.00E+02			kg	Other	Sweden

About Inventory	
Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .
Practitioner	Anders Abelmann - Chalmers University of Technology.
Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Sausage (Soy-Dog) production. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	nvironmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Sausage (Soy-Dog) production. ESA-DBP
Functional Unit	100 kg of 'Soy Dog'
Functional Unit Explanation	
Process Type	Gate to gate
Site	Swedish Meats, Örebro, Sweden

Sector	Food products and beverages
Owner	Swedish Meats, Örebro, Sweden
Technical system description	Excerpt from the report, see 'Function': ''Sausages are common food in many countries, with a history that dates far back. In the beginning it was a way to preserve meat for a long time, and also to use the parts of the animal that could not be used as whole meat. (...) In co-operation with Swedish Meats, a production facility in Örebro, Sweden, was studied. The reason for choosing the particular facility was that it mainly produces one product, named Hot Dogs. (...) The main production process consists of eight processes, of which some may be divided into two or more steps: (...) 1. Grinding - Frozen products are thawed before use. The meat ingredients are ground, and an automatic device is used to supervise the fat content. (NB: not applicable in case of Soy-Dog) 2. Pre-mixing - the meat mixture is mixed with water, ice, and salt. 3. Ripening in silo - storage of meat mixture, usually for 1-5 days. Six silos, each with a capacity of 12 tonnes. 4. Recipe mixing - mixing of meat mixture with other ingredients, such as potato starch and spices. A highly automated process, where the operator just defines the amounts, after which the mixture is prepared by the machine. 5. Extruding - four extruding machines, which are loaded with cellulose tubes. The sausage batter is extruded through the tubes at high speed, whereupon casing-covered sausages are formed. The cellulose casing is manufactured by Viscofan SA in Pamplona, Spain. Long strings of sausages are then cooked, smoked and cooled down. 6. Peeling of sausage strings - four parallel machines use steam to peel the casing off the sausages (NB: in case of Soy-Dog due to uncertainties of the feasibility of the recipe to actually hold together, the cellulose casing is not removed through the peeling process.) 7. Packaging - six packaging lines with various capacity, each including several steps: positioning, vacuum packaging (big rolls of plastic wrapping are heat-moulded into shape, sausages are inserted, and the packages are sealed), scale/metal detector, (defective products are removed), picker (a fast robot loads the packages into plastic trays), robot loading trays on pallet. 8. Loading area - facility office; stock input to logistics software, and back-reporting of customer orders. The aim of this study has been to model real and present conditions. However, the manufacturers were not able to share their recipes and therefore the following recipes were used in this study: - Hot Dog, based on an estimate of the real recipe. - Pea Dog, a hypothetical product based on the Hot Dog recipe, but with 10% of the animal protein substituted for pea protein. - Soy Dog, a hypothetical recipe based on the contents and nutritional value of Dafgård's soy sausage, with a protein content of about 7%. (...) Soy protein is the only plant protein which is 'complete', in the sense that it provides all the essential amino acids needed for human health. It is low in saturated fat and cholesterol-free. It is extracted from the soy bean, which is cultivated in temperate climates. Most of the Swedish and European soy is imported from Brazil in the form of soy meal and the lion's share of it is used in animal fodder. The most common vegetable sausage alternative is the soy sausage, which in Sweden is marketed by several manufacturers. The soy content usually consists of textured soy protein, which in turn consists of 70% protein and 23% dietary fibres. The concentrate is hydrolysed in order to obtain desirable properties. A presentation of the protein content in some soy products is shown below. Using the same yield as in the case of pea protein (65%) an amount of 3.6 kg of soy beans is needed to produce 1 kg of textured soy protein. As data on the protein extraction process is missing, the 'soy protein' input in the analysis is assumed to be equivalent to, and replaced by soy meal. The amount is based on protein level.'' This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Pea-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Pea cultivation. ESA-DBP - Production of beef. ESA-DBP - Production of pork. ESA-DBP - Rape seed cultivation. ESA-DBP - Wheat cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean processing. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries

Nature Boundary	Refined and natural resources as well as the energy use are included in the study.
Time Boundary	Excerpt from the report, see 'Publication': ''The goal has been to use as present data as possible. Most data on the Örebro facility is based on actual numbers from 2004.''
Geographical Boundary	The study was done for Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': ''The original recipe also included egg white powder, but since data on egg production was missing, and in order to present a fully-vegetable recipe, this has not been included.''

Allocations	Excerpt from the report, see 'Publication': ''Economic allocation was used for the different soy products. In this study, it is then assumed that 100% of the economic value of the soy meal can be allocated to the protein.''
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The recipes were modelled in the software and the energy use was adapted from the other report
Literature Reference	This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf
Notes	NB: The data were compiled from 2 tables: recipe and energy use.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Water	5.71E+01			kg	Water	Sweden
Notes: For peeling	Input	Refined resource	Biogas	2.79E+02			MJ	Technosphere	Sweden
	Input	Refined resource	Corn starch	7.90E+00			kg	Ground	Sweden
	Input	Refined resource	District heating	4.30E+01			MJ	Technosphere	Sweden
Notes: 0,05 MJ for grinding; 0,05 MJ for pre-mixing; 0,20 MJ for recipe mixing; 0,12 MJ for extruding; 0,12 MJ for conveyor; 0,086 MJ for peeling; 0,13 MJ for packaging and for the general use 1,22 MJ	Input	Refined resource	Electricity	1.98E+02			MJ	Technosphere	Sweden
Notes: For peeling	Input	Refined resource	Heat oil	1.28E+01			MJ	Technosphere	Sweden
	Input	Refined resource	Nitrite salt	1.80E+00			kg	Other	Sweden
	Input	Refined resource	Rape seed oil	1.32E+01			kg	Other	Sweden
	Input	Refined resource	Rice meal	7.90E+00			kg	Ground	Sweden
	Input	Refined resource	Soy protein	1.23E+01			kg	Other	Sweden
	Input	Refined resource	Sugar beet pulp	3.10E+00			kg	Ground	Sweden
	Output	Product	Sausage Soy - Dog	1.00E+02			kg	Other	Sweden

About Inventory

Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .
Practitioner	Anders Abelmann - Chalmers University of Technology.

Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Sawed construction timber production

Administrative	
Finished	Y
Date Completed	1996-04-02
Copyright	Trätek(The Swedish Institute for Wood Technology) Research)
Availability	Public

Technical System	
Name	Sawed construction timber production
Functional Unit	kg
Functional Unit Explanation	1 kg sawed construction timber
Process Type	Cradle to gate
Site	Sweden, an area between Norrland (Piteå) and Småland (Möcklen)
Sector	Materials and components
Owner	Sweden, an area between Norrland (Piteå) and Småland (Möcklen)
Technical system description	The study comprises forestry, production of wooden material at the sawmill, transports from forest to sawmill and internal transports at the sawmill. The average transport distance between the forest and the sawmill is about 55 km.

System Boundaries	
Nature Boundary	Ashes from the sawmill are brought back to the forest and waste bark is used for road filling. This study includes environmental loadings such as material resource, resources for energy production, waste and emissions to air and water.
Time Boundary	
Geographical Boundary	Sweden, an area between Norrland (Piteå) and Småland (Möcklen)
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1996-04-02
Data Type	Unspecified
Represents	See 'Function'
Method	Average of the environmental declaration of 16 Swedish sawmills (Trätek). The original data in the environmental declarations have been modified through exclusion of the environmental load for packaging material.

Literature Reference	Environmental declarations, Sawed timber, Report 9604027, Trätek (The Swedish Institute for Wood Technology Research)
Notes	The density of sawed construction timber is 460 kg/m3 (dry substance). Average values from 16 Swedish sawmill's inventory: Fiskarhedens Trävaru AB, Gällö Kilafors Trä AB, Gällö Såg, Kilafors Trävaru, Hissmofors AB, Kastets Sågverk, Korsnäs Timber AB, Kopparforsens Sågverk, STORA, Timber AB, Lövholmens Trä AB, Moelven Dala Trä AB, AB Möckels Sågverk, Nyby Sågverk Mälarskog Industrier AB, OLAB Trä, Östavallssågen SAEF AB, Siljans Sågverk AB, Skinnskattebergs Trä AB, Åtvidabergs Trävaru AB

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Renewable fuel	2.5			MJ	Other	
	Input	Natural resource	Round Timber	1200			g	Other	
	Input	Refined resource	Diesel	0.478			MJ	Other	
	Input	Refined resource	Electricity	0.494			MJ	Other	
	Input	Refined resource	Oil	0.0761			MJ	Other	
	Output	Emission	Ashes	2.96			g	Ground	
	Output	Emission	CO	2.68			g	Air	
	Output	Emission	CO2	40.9			g	Air	
	Output	Emission	HC	0.565			g	Air	
	Output	Emission	NOx	1			g	Air	
	Output	Emission	Particles	0.359			g	Air	
	Output	Emission	SO2	0.152			g	Air	
Data type: Calculated Method: The data is recounted from m3 to kg. The	Output	Product	Sawed timber	1			kg	Technosphere	
	Output	Residue	Hazardous waste	0.0761			g	Other	
	Output	Residue	Waste bark	3.42			g	Other	

About Inventory

Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund, Tillman; Report 1997:2; TEP; CTH; Göteborg; Sweden¨ --- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology ---
Intended User	Environmental declaration
General Purpose	To survey the environmental load of sawed construction timber
Detailed Purpose	
Commissioner	
Practitioner	Björklund Thomas, Tillman Anne-Marie - Technical Environmental Planning, CTH 412 96 Göteborg Sweden.
Reviewer	
Applicability	Valid for timber with a moister content of 18 percent, which is normal for constructional timber at building sites of today. The density of unprocessed coniferous wood is 460 kg/m3 (dry substance). The function of the technical system is not sufficently described.
About Data	Average values from 16 Swedish sawmills inventory: Fiskarhedens Trävaru AB, Gällö Kilafors Trä AB, Gällö Såg, Kilafors Trävaru, Hissmofors AB, Kastets Sågverk, Korsnäs Timber AB, Kopparforsens Sågverk, STORA, Timber AB, Lövholmens Trä AB, Moelven Dala Trä AB, AB Möckels Sågverk, Nyby Sågverk Mälarskog Industrier AB, OLAB Trä, Östavallssågen SAEF AB, Siljans Sågverk AB, Skinnskattebergs Trä AB, Åtvidabergs Trävaru AB
Notes	-- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 12 June 2001 <<< Changes made by Ann-Christin Pålsson, based on the original report (Björklund et al.). Comments: - A input flow of 'Feedstock energy' (18,2 MJ) in the flow table has been deleted due to that it represented the energy content of the product, and not a real physical flow. - Practitioner and Publication: Changed from Trätek, to Björklund Tillman, since the documentation in SPINE@CPM is based on the interpretation made by Björklund, Tillman. Some minor modifications of the report by Trätek has been made by Björklund Tillman. - Applicability; A text in refererring to Trätek for further information about the data set has been

SPINE LCI dataset: Scalable electric traction motor, permanent magnet (PMSM), for EVs

Administrative	
Finished	Y
Date Completed	2016-07-01
Copyright	Anders Nordelöf
Availability	Public

Technical System	
Name	Scalable electric traction motor, permanent magnet (PMSM), for EVs
Functional Unit	1 piece of electric traction motor, specified by its output in power (20-200 kW) and torque (48-477 Nm)
Functional Unit Explanation	
Process Type	Gate to gate
Site	
Sector	Process
Owner	
Technical system description	The dataset consists of a general and scalable LCI data model for a(n) (internal) permanent magnet synchronous electric motor, (I)PMSM, designed for electric vehicle propulsion. It provides the mass composition and manufacturing data for a typical automotive electrical machine design, as delivered at the factory gate. The model file generates data on motors ranging in power from 20-200 kW and in torque from 48-477 Nm, i.e. from a small electric passenger vehicle up to, for example, an electrically propelled bus. It is a gate-to-gate LCI, with inputs as delivered from various stages of material processing. All input and output flows have recommended matching output and input flows from LCI process datasets or elementary flows included in ecoinvent v 3. The LCI is possible to combine with input data for virgin raw materials as well as recycled materials. Use (operation and maintenance) and end-of-life treatment is NOT included in the dataset. Adjustable model parameters: * Maximum power (kW) * Maximum torque (Nm), allowing for base speeds within 3000-5000 rpm (default: 4000 rpm) * Inclusion/exclusion of electromagentically passive parts: housing (body and endbells on each side), shaft, bearings Input flows: * Products flows, as "product material input" (materials and subparts) and "processing input" (input to production, but not a part of the final product). * Energy use in production Output flows: * Product flow: 1 piece of electric motor * Waste - typically metal scrap, sludge or used process liquids * Emissions to air and water The model has been setup with a regular system boundary and an extended system boundary. The regular boundary encircles the inventoried gate-to-gate system. The latter encircles a set of ecoinvent activities for material transformation and coating included to account for the making of several subparts from their material constituents. These activities are listed separately from the inventory defined by the regular system boundaries, to avoid confusion for the user, see the model report. The model file presents an aggregated inventory list (and an aggregated activity list, see above) on the summary page, as well as all flows in and out of each unit process (including all internal flows of the gate-gate system). Extended system activities are also presented both aggregated (in a list on the summary page) and individually for each related flow. Finally, uncertainty has been quantified for all data on the unit process level (not for aggregated results) by the authors, based on qualitative assessment of data quality according to the ecoinvent pedigree matrix approach, see Appendix A of the model report. For a full description on the methodology, theory and data processing that has led to the inventory details presented in the model file, please read the model report.

System Boundaries	
Nature Boundary	See model report.
Time Boundary	See model report.
Geographical Boundary	See model report.
Other Boundaries	See model report.
Allocations	See model report.
Systems Expansions	See model report.

Flow Data

General Activity QMetaData	
Date Conceived	See model report.
Data Type	Derived, mixed
Represents	See model report.
Method	All flows are calculated using the model file "Scalable PMSM LCI Model.xlsx" http://cpmdatabase.cpm.chalmers.se/DataReferences/Scalable_PMSM_LCI_Model_v1.01.xlsm
Literature Reference	See model report.
Notes	The density of sawed construction timber is 460 kg/m3 (dry substance). Average values from 16 Swedish sawmill's inventory: Fiskarhedens Trävaru AB, Gällö Kilafors Trä AB, Gällö Såg, Kilafors Trävaru, Hissmofors AB, Kastets Sågverk, Korsnäs Timber AB, Kopparforsens Sågverk, STORA, Timber AB, Lövholmens Trä AB, Moelven Dala Trä AB, AB Möckels Sågverk, Nyby Sågverk Mälarskog Industrier AB, OLAB Trä, Östavallssågen SAEF AB, Siljans Sågverk AB, Skinnskattebergs Trä AB, Åtvidabergs Trävaru AB

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Output	Product	Electric traction motor, permanent magnet (PMSM), for EVs	1			pce	Technosphere	World

About Inventory	
Publication	Model file: Nordelöf A (2017) Scalable IPMSM LCI Model v1.01.xlsm [Online]. Version 1.01. Gothenburg, Sweden: Environmental Systems Analysis; Chalmers University of Technology. Distributed by The Swedish Life Cycle Center.Available: http://cpmdatabase.cpm.chalmers.se/DataReferences/Scalable_PMSM_LCI_Model_v1.01.xlsm Model report: Nordelöf A, Grunditz E, Tillman A-M, Thiringer T, Alatalo M (2017) A Scalable Life Cycle Inventory of an Electrical Automotive Traction Machine - Technical and Methodological Description, version 1.01. Report No. 2016:4 (1.01). Environmental Systems Analysis & Electric Power Engineering, Chalmers University of Technology, Gothenburg, Sweden. Available: http://cpmdatabase.cpm.chalmers.se/DataReferences/LCI_model_report_PMSM_v1.01.pdf
Intended User	See model report.
General Purpose	See model report.
Detailed Purpose	See model report.
Commissioner	
Practitioner	Anders Nordelöf - Environmental Systems Analysis, Chalmers University of Technology.
Reviewer	
Applicability	See model report.
About Data	See model report.
Notes	

SPINE LCI dataset: Scalable inverter unit, electric motor controller, IGBT transistors, for EVs

Administrative

Finished	Y
Date Completed	2018-10-02
Copyright	Anders Nordelöf
Availability	Public

Technical System	
Name	Scalable inverter unit, electric motor controller, IGBT transistors, for EVs
Functional Unit	1 inverter unit (piece) for electric motor control
Functional Unit Explanation	The inverter unit is scalable and specified by its output power (20-200 kW) and input DC system voltage (250-700 V).
Process Type	Gate to gate
Site	
Sector	Machinery and equipment
Owner	
Technical system description	The dataset consists of a general and scalable LCI data model for an inverter unit designed for electric vehicle motor control. It provides the mass composition and manufacturing data for a typical automotive inverter unit design containing IGBT transistors, as delivered at the factory gate. The model file generates data on inverter units ranging in power from 20-200 kW and DC system voltage from 250-700 V, i.e. from a small electric passenger vehicle up to, for example, an electrically propelled bus. It is a gate-to-gate LCI, with inputs as delivered from various stages of material processing. All input and output flows have recommended matching output and input flows from LCI process datasets or elementary flows included in ecoinvent v 3. The LCI is possible to combine with input data for virgin raw materials as well as recycled materials. Use (operation and maintenance) and end-of-life treatment is NOT included in the dataset. Adjustable model parameters: * Nominal power (kW), output on AC side * Nominal DC system voltage (V), input on DC side, typically from a battery * Selection of cooling method/type of heatsink: air cooling (up to 50 kW) or liquid cooling (complete range) * Inclusion/exclusion of parts with large design variability: casing (including integrated HV connectors) and laminated bus bar. Input flows: * Products flows, as "product material input" (materials and subparts) and "processing input" (input to production, but not a part of the final product). * Energy use in production Output flows: * Product flow: 1 piece of inverter / electric motor controller * Waste - typically metal scrap, sludge or used process liquids * Emissions to air and water The model has been setup with a regular system boundary and an extended system boundary. The regular boundary encircles the inventoried gate-to-gate system. The latter encircles a set of ecoinvent activities for material transformation, coating and assembly included to account for the making of several subparts from their material constituents. These activities are listed separately from the inventory defined by the regular system boundaries, to avoid confusion for the user, see the model report. The model file presents an aggregated inventory list (and an aggregated activity list, see above) on the summary page, as well as all flows in and out of each unit process (including all internal flows of the gate-gate system). Extended system activities are also presented both aggregated (in a list on the summary page) and individually for each related flow. For a full description on the methodology, theory and data processing that has led to the inventory details presented in the model file, please read the model report.

System Boundaries	
Nature Boundary	See model report
Time Boundary	See model report
Geographical Boundary	See model report
Other Boundaries	See model report
Allocations	See model report
Systems Expansions	See model report

Flow Data	
General Activity QMetaData	
Date Conceived	

Data Type	
Represents	See model report
Method	See model report
Literature Reference	See model report
Notes	The density of sawed construction timber is 460 kg/m3 (dry substance). Average values from 16 Swedish sawmill's inventory: Fiskarhedens Trävaru AB, Gällö Kilafors Trä AB, Gällö Såg, Kilafors Trävaru, Hissmofors AB, Kastets Sågverk, Korsnäs Timber AB, Kopparforsens Sågverk, STORA, Timber AB, Lövholmens Trä AB, Moelven Dala Trä AB, AB Möckels Sågverk, Nyby Sågverk Mälarskog Industrier AB, OLAB Trä, Östavallssågen SAEF AB, Siljans Sågverk AB, Skinnskattebergs Trä AB, Åtvidabergs Trävaru AB

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Output	Product	Inverter unit, electric motor controller, IGBT transistors, for EVs	1			pce	Technosphere	World

About Inventory

Publication	Nordelöf, A. (2018) Scalable Power Electronic Inverter LCI model.xlsm. Version 1.01. Gothenburg, Sweden: ENVIRONMENTAL SYSTEMS ANALYSIS; CHALMERS UNIVERSITY OF TECHNOLOGY. Available: Scalable_Power_Electronic_Inverter_LCI Model_v1.01.xlsm Model report: Nordelöf, A. & Alatalo, M. (2018). A Scalable Life Cycle Inventory of an Automotive Power Electronic Inverter Unit - Technical and Methodological Description, version 1.01. 2018, Gothenburg, Sweden: Divisions of Environmental Systems Analysis & Electric Power Engineering, Chalmers University of Technology. ESA report no. 2016:5 (1.01). Available: LCI model report inverter unit v1.01 Final.pdf
Intended User	See model report
General Purpose	See model report
Detailed Purpose	See model report
Commissioner	
Practitioner	Anders Nordelöf - Environmental Systems Analysis, Chalmers University of Technology.
Reviewer	
Applicability	See model report
About Data	See model report
Notes	

SPINE LCI dataset: Scrap-based aluminium production

Administrative

Finished	Y
Date Completed	1996-05-01
Copyright	[HOLDER OF COPYRIGHT]
Availability	AUTORIZATIONS AND SECRECY:

Technical System

Name	Scrap-based aluminium production
Functional Unit	kg
Functional Unit Explanation	Inventory result for production of 1 kg scrap-based aluminium.
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	

Technical system description	BRIEF DESCRIPTION: The raw material used for the scrap-based aluminium production are NaOH, salt (NaCl), chlorine and scrap-aluminium. The production of these raw materials are calculated for in this study. The energy use at the production plant at Gotthard Aluminium in Älmhult, Sweden, is included. The transports of raw materials to the scrap-based aluminium production plant at Gotthard Aluminium in Älmhult, Sweden, are assumed to be standard distances and standars conveyance (that is, long distance road), except for transport of salt. The distances are for NaOH 300 km, salt 800 km (from Germany), chlorine 300 km and scrap 300 km.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: This study includes environmental loadings such as material resources, resources for energy production, waste and emissions to air and water.
Time Boundary	LIFETIME/APPLICABLE TIME OF SYSTEM/PRODUCT (delete the inappropriate alternative): The data is collected during the early nineties and one should consider some change i process steps etc. as times go.
Geographical Boundary	GEOGRAPHICAL EXTENSION (for large technical systems) The known processes takes place in Sweden (recycling process) and Germany (salt production). It is not known where the production of NaOH and chlorine takes place, but it is assumed to take place in Sweden. It is not known where the scrap is taken from.
Other Boundaries	
Allocations	DESCRIPTION: The allocations in this study is based on massflow.
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study) No.

Flow Data

General Activity QMetaData

Date Conceived	1996-05-01
Data Type	Derived, unspecified
Represents	See model report
Method	Taken from table 10 in Sunér M. Life Cycle Assessment of Aluminium, Copper and Steel.
Literature Reference	Life Cycle Assessment of Aluminium, Copper and Steel; Maria Sunér; Technical Environmental Planning; Report 1996:6; Chalmers University of Technology; Gothenburg; Sweden
Notes	The density of sawed construction timber is 460 kg/m3 (dry substance). Average values from 16 Swedish sawmill's inventory: Fiskarhedens Trävaru AB, Gällö Kilafors Trä AB, Gällö Såg, Kilafors Trävaru, Hissmofors AB, Kastets Sågverk, Korsnäs Timber AB, Kopparforsens Sågverk, STORA, Timber AB, Lövholmens Trä AB, Moelven Dala Trä AB, AB Möckels Sågverk, Nyby Sågverk Mälarskog Industrier AB, OLAB Trä, Östavallssågen SAEF AB, Siljans Sågverk AB, Skinnskattebergs Trä AB, Åtvidabergs Trävaru AB

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Coal	4.13			g	Other	
	Input	Natural resource	Hydro power	0.392			g	Other	
	Input	Natural resource	Iron ore	0.551			mg	Ground	
	Input	Natural resource	Limestone	15.2			mg	Ground	
	Input	Natural resource	NaCl	0.97			g	Other	
Notes: 0,492 g of the oil is a resource for the electricity production, 2,04 g is a energy resource for the precombustion.	Input	Natural resource	Natural gas	2.532			g	Ground	
	Input	Natural resource	Peat	0.383			g	Other	
	Input	Natural resource	Sand	0.182			mg	Other	
	Input	Natural resource	Uranium ore	0.511			mg	Ground	
	Input	Natural resource	Water	1.73			g	Other	
	Input	Refined resource	Electricity	0.0139			MJ	Technosphere	

	Input	Refined resource	Scrap	1150			g	Technosphere	
Notes: Acid as H+.	Output	Emission	Acidification eq	0.294			mg	Water	
	Output	Emission	Aldehydes	3.09			g	Air	
	Output	Emission	BOD	2.72			ug	Water	
Notes: 0,125 mg is emission to air from electricity production.	Output	Emission	CH4	19.3			mg	Air	
	Output	Emission	Chloride	35.4			mg	Water	
Notes: 1,88 mg is emission to air from electricity production.	Output	Emission	CO	0.158			g	Air	
Notes: 10,1 g is emission to air from electricity production.	Output	Emission	CO2	474.1			g	Air	
	Output	Emission	COD	9.70			ug	Water	
	Output	Emission	Dissolved solids	45.4			ug	Water	
Notes: 0,943 mg is emission to air from electricity production.	Output	Emission	HC	0.154			g	Air	
	Output	Emission	HCl	0.323			g	Air	
	Output	Emission	HF	80.6			mg	Air	
	Output	Emission	Metals	1.82			mg	Air	
	Output	Emission	Metals	77.6			ug	Water	
Notes: 0,410 mg is emission to air from electricity production.	Output	Emission	N2O	2.69			mg	Air	
	Output	Emission	Na	2.81			mg	Water	
Notes: 39,3 mg is emission to air from electricity production.	Output	Emission	NOx	0.747			g	Air	
Notes: Oil and emulsions.	Output	Emission	Oil	5.00			g	Water	
Notes: 0,391 mg is emission to air from electricity production.	Output	Emission	Particulates	0.265			g	Air	
	Output	Emission	Phenol	2.85			ug	Water	
Notes: 40,8 mg is emission to air from electricity production.	Output	Emission	SO2	1.051			g	Air	
	Output	Emission	SOx	13			mg	Air	
	Output	Emission	Sulphates	5.85			mg	Water	
	Output	Emission	Susp solids	1.65			mg	Water	
	Output	Product	Aluminium	1			kg	Technosphere	
Notes: Waste from electricity production.	Output	Residue	Ashes	80.3			mg	Other	
	Output	Residue	Industrial waste	0.908			mg	Other	
	Output	Residue	Inert chemicals	10.6			mg	Other	
	Output	Residue	Mineral waste	61.8			mg	Other	
Notes: Salt waste.	Output	Residue	Other rest products	253			g	Other	
Notes: Waste from electricity production.	Output	Residue	Radioactive waste	27.7			mg	Other	
	Output	Residue	Regulated chemicals	18.2			ug	Other	
Notes: The waste consist of slag and ashes.	Output	Residue	Slag	11.4			mg	Other	
	Output	Residue	Sludge	26.9			g	Other	
	Output	Residue	Waste	32.6			g	Other	

About Inventory	
Publication	Life Cycle Assessment of Aluminium, Copper and Steel; Maria Sunér; Technical environmental planning; Report 1996:6; Chalmers University of Technology; Göteborg; Sweden. --- Data documented by: Maria Erixon, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	Anyone who wants to make a Lif
General Purpose	To make an LCA for Al, Cu and steel.
Detailed Purpose	The data is presented in the report Life Cycle Assessment of Aluminium, Copper and Steel. The purpose of the report was to collect and present inventory data on production and recycling of the three materials aluminium, copper and steel of higher quality than earlier published data.
Commissioner	
Practitioner	Sunér, Maria - Teknisk Miljöplanering Chalmers Tekniska Högskola 412 96 Göteborg Sweden.
Reviewer	

Applicability	CERTAIN CAUTIONS: The data for the recycling process in this study are from Gotthard Aluminium in Älmhult, Sweden. The data is taken mainly from their environmental report from 1993. During 1994 the company made several environmental improvements, which can change the environmental load calculated in this study. Data for virgin aluminium production is to be found in this database at Virgin aluminium production.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data for the recycling process is taken from Gotthard Aluminium in Älmhult, Sweden. It is data from an Environmental Report. It is not known in what chemical form the metal emissions to air or water are. The NaOH and chlorine production is assumed to take place in Sweden and NaCl (mining and refining, that is crushing and grinding) in Germany.
Notes	

SPINE LCI dataset: Scrap-based steel production

Administrative	
Finished	Y
Date Completed	1996-10-01
Copyright	
Availability	Public

Technical System	
Name	Scrap-based steel production
Functional Unit	kg
Functional Unit Explanation	1 kg scrap-based steel
Process Type	Gate to gate
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	The scrap-based steel production includes the following steps: Scrap refining; Production of slag formers; Coal mining; Steel production (scrap pre-heating, steel plant, casting of billets, rolling (fine and medium rolling)). The transports mentioned below are accounted for in this set of data. Scrap refining Scrap is transported 40 km by lorry from earlier user to scrap refining plant. All sorts of metals are received (brass, copper, aluminum etc.), but about 90% is iron and steel. In the refining process, scrap is sorted according to metal. Larger fragments are first cut down with gas beams and then cut into final suitable shape and taken to a steel plant. From the scrap refining plant the scrap is transported about 300 km by train. Production of slag formers Lime is transported from Rättvik, about 120 km with lorry. Coal mining Coal is imported from Finland, Germany and some other countries. It is transported to Stockholm or Västerås by boat, at the average 500 km, and then 180 km by lorry from Västerås and Stockholm to Smedjebacken.

System Boundaries	
Nature Boundary	This study includes environmental loadings such as material resources, resources for energy production, waste and emissions to air and water.
Time Boundary	
Geographical Boundary	Sweden, except for the coal mining which is done in Australia and USA.
Other Boundaries	

Allocations	Steel production The environmental load for cutting and bending is insignificant compared to total environmental impact of other process steps, and thus the total environmental load is allocated to products from the steel plant and the rolling mill. Rod iron profiles are main products, to which the environmental impact is allocated. Rolling As liquefied petroleum gas (LP gas) is mainly used in the rolling mills (though a minor part is used in the pre-heating of tun-dishes), its environmental impact is allocated to rolled products. Further, following parameters are allocated to production in the rolling mills: - All emissions to water - NOX (emission to air) - Chemicals (resource)
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Derived, unspecified
Represents	See model report
Method	Inventory
Literature Reference	Product information, Fundia AB, Upplands Väsby, 1994 Miljörapport (Environmental report) 1994, Fundia Special Bar AB, Smedjebacken, 1995
Notes	The analysis is based on an inventory and the environmental data for production of scrap-based steel is taken from Fundia in Smedjebacken. Stena Metall (Scrap refining) Fundia Special Bar (Steel production)

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Coal	0.223			MJ	Ground	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Gas	1.58			MJ	Ground	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Limestone	53.8			g	Ground	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Alloy materials	17			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Chemicals	0.834			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Diesel	0.0543			MJ	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Electricity	2.06			MJ	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Explosives	0.0108			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Heavy oil (eo5)	0.109			MJ	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Oil (eo1)	0.13			MJ	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Scrap	1110			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Al	0.00000819			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Ashes	0.159			g	Air	

Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Ca	0.00208			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	CH4	0.0639			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cl	0.00287			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	CO	0.0179			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	CO2	214			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	COD	0.0000636			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cr	0.000144			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cu	0.000144			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Dissolved solids	0.00819			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	F	0.0000000246			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Fe	0.0000819			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Fe	0.0244			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	HC	0.0133			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Mg	0.00000819			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NH3	0.00000819			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Ni	0.000000819			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Ni	0.000022			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NOx	0.95			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	N-tot	0.0000104			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Oil (aq)	0.000775			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Particles	0.0612			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Pb	0.00215			g	Air	

Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Phenol	0.00000031			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	SO4--(air)	0.00409			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	SOx	0.354			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Sr	0.0000819			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Susp solids	0.00198			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Zn	0.0000788			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Zn	0.0178			g	Air	
	Output	Product	Steel	1			kg	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Hazardous waste	0.101			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Industrial waste	123			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Mineral waste	0.00561			g	Other	

About Inventory

Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden -- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology --
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural concrete and steel frames in buildings during the whole life-cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of steel production
Commissioner	- Trätek (The Swedish Institute for Wood Technology Research) .
Practitioner	Björklund Thomas, Tillman Anne-Marie - Technical Environmental Planning, CTH 412 96 Göteborg Sweden.
Reviewer	
Applicability	
About Data	Scrap refining In 1994/95 the average energy use was about 0.046 MJ/kg scrap. It is assumed that all used energy is electricity. No process waste occurs. Production of slag formers For the calculations it is assumed that all slag formers consist of lime. Coal mining Half the amount of coal is imported from Australia and half from USA. The data used are average values for mineral coal used in Europe based on 50% open-pit mining and 50% underground mining. Steel production Filter dust (14.5 g/kg) and glow scales (11.6 g/kg) is defined as low-grade products and carry no upstream environmental impact. Both these products have an economical value and are used in other industrial processes. The filter dust mainly consists of iron and zinc. As alloy materials, mainly ferrosilicon manganese and ferrosilicon is used. The alloy materials are mainly bought from alloy plants in Norway, although the ore is mined elsewhere. The environmental impact of mining and extraction of alloy materials are treated

	as non-elementary flows. In coal and coke is also included some antracite electrodes. As coal and coke are primarily used as raw materials, these parameters are in the calculations accounted for primarily as material use and not as energy use. Chemicals are mainly used for water treatment, mostly aluminium sulphate and sodium hydroxide. Chemicals are treated as non-elementary flows. Ceramic materials used for mending the ovens are omitted in the calculations, as the amounts are negligible (0.697 g/kg). The environmental load of oxygen production (0.026 Nm3/kg steel) is treated as a non-elementary flow in the calculations, as no data have been easily available for this process. Some energy recovered in the process is transferred as heated water to the municipal district heating system (0.123 MJ/kg), and this energy has been deducted from the electricity use. CO2 emissions are calculated based on use of fossil fuels. It is assumed in the calculations that the fine- and medium-rolling mills are equal in environmental impact per produced weight unit.
Notes	

SPINE LCI dataset: Scrap-based steel production

Administrative	
Finished	Y
Date Completed	1996-05-01
Copyright	
Availability	Public.

Technical System	
Name	Scrap-based steel production
Functional Unit	kg
Functional Unit Explanation	Inventory result for production of 1 kg scrap-based steel billets.
Process Type	Gate to gate
Site	
Sector	Materials and components
Owner	
Technical system description	Included in the Scrap-based steel production: The steel production at Fundia Steel AB (in Smedjebacken, Sweden) is entirely based on scrap and no virgin steel is added. Scrap, alloy material, slag formers, coal and coke are used in the production of scrap-based steel. Limestone and bentonite are the raw materials in the slag former production. The raw material production are included in this study, except for scrap (the scrap is treated as an inflow not traced back to the cradle). Alloy material production includes mining and dressing. Coal and coke production includes coal mining. The steel are casted into billets in the steel plant. -- Coal is transported from Australia, Poland and USA to the coke production and the average distance is estimated to10 000 km by boat and 833 km by train. The transports of Scrap, Alloy material, Slag former, Coke and Coal to the steel plant is assumed to be 300 km by road (standard distances and modes of conveyance) respectivly.

System Boundaries	
Nature Boundary	Emissions to air and water, waste and natural resources.
Time Boundary	The data is collected during the early nineties and one should consider some change i process steps etc. as times go.
Geographical Boundary	The scrap-based steel production is, as well as the coke production, taken place in Sweden. The alloy material production, limestone and bentonite mining are assumed to take place in Sweden. Coal is imported from Australia, Poland and USA.
Other Boundaries	The scrap is treated as an inflow not traced back to the cradle.
Allocations	

Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	1996-05-01
Data Type	Derived, unspecified
Represents	See model report
Method	Taken from table 28 in Sunér M. Life Cycle Assessment of Aluminium, Copper and Steel.
Literature Reference	Life Cycle Assessment of Aluminium, Copper and Steel; Maria Sunér; Report 1996:6; Technical Environmental Planning; Chalmers University of Technology; Göteborg; Sweden
Notes	The analysis is based on an inventory and the environmental data for production of scrap-based steel is taken from Fundia in Smedjebacken. Stena Metall (Scrap refining) Fundia Special Bar (Steel production)

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Bauxite	0.860			mg	Other	
	Input	Natural resource	Chalice	9.20			mg	Other	
Notes: 7,55 g is used as material resources and 3,17 g as resources for electricity production.	Input	Natural resource	Coal	10.7			g	Other	
	Input	Natural resource	Dolomite	26.7			g	Other	
	Input	Natural resource	Feldspar	2.76			ug	Other	
	Input	Natural resource	Hydro power	0.696			g	Other	
	Input	Natural resource	Lime	5.31			ug	Other	
	Input	Natural resource	Limestone	27.8			g	Other	
	Input	Natural resource	Magneese containing compounds	16.9			g	Other	
	Input	Natural resource	Na2SO4	97.3			ug	Other	
Notes: 0,311 g is used as resource for electricity production, 0,228 g for precombustion and 2,48 mg is material resource.	Input	Natural resource	Natural gas	1.32			g	Other	
	Input	Natural resource	Oil	0.353			mg	Other	
	Input	Natural resource	Peat	0.683			g	Other	
	Input	Natural resource	Sand	30.5			ug	Other	
	Input	Natural resource	Uranium	0.881			mg	Other	
	Input	Natural resource	Water	0.536			g	Other	
	Input	Refined resource	Diesel	86.2			mg	Technosphere	
	Input	Refined resource	Electricity	21.5			MJ	Technosphere	
	Input	Refined resource	Emulsifier	60.1			ug	Technosphere	
Notes: 1,91 g is used as resource for electricity production and 0,506 g for precombustion.	Input	Refined resource	Fuel oil	11.4			g	Technosphere	
	Input	Refined resource	Portland soda	4.36			ug	Technosphere	
	Input	Refined resource	Renewable energy source	3.76			g	Technosphere	
	Input	Refined resource	Scrap	1110			g	Technosphere	
	Input	Refined resource	Solvey soda	4.36			ug	Technosphere	
	Output	Emission	Al	7.55			ug	Water	
	Output	Emission	Aldehydes	1.99			ug	Air	
	Output	Emission	As	0.302			ug	Air	
	Output	Emission	As	21.1			ng	Water	
	Output	Emission	BOD	0.112			ug	Water	
	Output	Emission	Ca	1.99			mg	Air	
Notes: 0,222 mg is emitted to air from the electricity production.	Output	Emission	CH4	44.5			mg	Air	

Notes: 12,8 ug is emitted to air from the electricity production.	Output	Emission	Chloride	264			mg	Water	
Notes: 3,29 mg is emitted to air from the electricity production.	Output	Emission	CO	0.116			g	Air	
Notes: 6,37 g is emitted to air from the electricity production.	Output	Emission	CO2	39.7			g	Air	
Notes: 0,340 ug is emitted to air from the electricity production.	Output	Emission	COD	257			ug	Water	
	Output	Emission	Cr	0.137			mg	Air	
	Output	Emission	Cr	96.3			ng	Water	
	Output	Emission	Cu	0.138			mg	Air	
	Output	Emission	Cu	0.151			ug	Water	
	Output	Emission	Dissolved solids	0.241			mg	Water	
	Output	Emission	Fe	23.2			mg	Air	
Notes: 2,28 ng is emitted to air from the electricity production.	Output	Emission	Fe	75.5			ug	Water	
	Output	Emission	Fluorides	1.02			ug	Water	
	Output	Emission	Fluorides	7.58			ng	Air	
Notes: 3,29 mg is emitted to air from the electricity production.	Output	Emission	HC	82.1			mg	Air	
	Output	Emission	HNO3	0.147			ug	Water	
	Output	Emission	Mn	4.48			ug	Water	
Notes: 0,721 mg is emitted to air from the electricity production.	Output	Emission	N2O	2.36			mg	Air	
	Output	Emission	Na+	0.167			ug	Water	
	Output	Emission	NaCl	0.461			ug	Water	
Notes: 0,392 ug is emitted to air from the electricity production.	Output	Emission	NH3	9.68			ug	Air	
	Output	Emission	NH4-N	41.0			ug	Water	
	Output	Emission	NH4NO3	10.7			ug	Water	
	Output	Emission	NH4NO3	2.93			ug	Air	
	Output	Emission	Ni	0.828			ug	Water	
	Output	Emission	Ni	20.5			ug	Air	
Notes: 0,241 ug is emitted to air from the electricity production.	Output	Emission	NO3-N	8.29			ug	Water	
Notes: 15,6 mg is emitted to air from the electricity production.	Output	Emission	NOx	0.551			g	Air	
Notes: 1,87 pg is emitted to air from the electricity production.	Output	Emission	N-tot	0.228			mg	Water	
Notes: 3,66 ug is emitted to air from the electricity production.	Output	Emission	Oil	0.53			mg	Water	
	Output	Emission	PAH	1.37			ug	Air	
Notes: 0,261 mg is emitted to air from the electricity production.	Output	Emission	Particulates	67.4			mg	Air	
	Output	Emission	Pb	2.05			mg	Air	
	Output	Emission	Pb	22.9			ng	Water	
Notes: 0,0556 pg is emitted to air from the electricity production.	Output	Emission	Phenol	2.37			ug	Water	
	Output	Emission	P-tot	2.52			ug	Water	
	Output	Emission	Radon-222	0.0906			kBq	Air	
Notes: 12,6 mg is emitted to air from the electricity production.	Output	Emission	SO2	0.123			g	Air	
Notes: 0,214 ug is emitted to air from the electricity production.	Output	Emission	SO4 2-	3.77			mg	Water	
	Output	Emission	SOx	1.78			mg	Air	
	Output	Emission	Sr	75.5			ug	Water	
Notes: 0,112ug is emitted to air from the electricity production.	Output	Emission	Susp solids	0.956			mg	Water	
	Output	Emission	Tot-CN	2.06			ug	Water	
	Output	Emission	V	82.3			ng	Air	
	Output	Emission	Zn	17.6			mg	Air	
	Output	Emission	Zn	41.8			ug	Water	
	Output	Product	Steel	1			kg	Technosphere	
Notes: Waste from the electricity production.	Output	Residue	Ashes	0.111			g	Other	
Notes: 18,7 ug is explosive remains.	Output	Residue	Hazardous waste	0.476			mg	Other	
Notes: Waste from the electricity production.	Output	Residue	Highly active rad ac waste	1.04			ng	Other	
Notes: Waste from the electricity production.	Output	Residue	Medium active rad ac waste	5.51			ng	Other	
Notes: Other rest products contains: 1123 g slag 14,5 g filter dust 1,71 g brick 1,18 g waste 0,170 g grinding dust 0,598 mg redmud 33,5 ug dust	Output	Residue	Other rest products	1140			g	Other	
Notes: Waste from the electricity production.	Output	Residue	Radioactive waste	47.7			mg	Other	

Notes: 11,6 g is production waste and 11,6 g excessive remains.	Output	Residue	Scrap	23.2			g	Other	

About Inventory	
Publication	Life Cycle Assessment of Aluminium, Copper and Steel; Maria Sunér; Technical Environmental Planning; Report 1996:6; Chalmers University of Technology; Gothenburg; Sweden -- Data documented by: Maria Erixon, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	To make an LCA for Al, Cu and steel.
Detailed Purpose	The data is presented in the report Life Cycle Assessment of Aluminium, Copper and Steel. The purpose of the report was to collect and present inventory data on production and recycling of the three materials aluminium, copper and steel of higher quality than earlier published data.
Commissioner	
Practitioner	Sunér, Maria - Teknisk Miljöplanering Chalmers Tekniska Högskola 412 96 Göteborg Sweden.
Reviewer	
Applicability	
About Data	The data for the production of Scrap-basd steel at Fundia Steel AB is taken from their Environmental report 1994. Alloy material As alloy material manganese ore is assumed. As no data are available on manganese ore mining data valid for iron ore mining are used. The data on iron ore mining and dressing is taken from the production in Malmberget, Sweden (LKAB). Slag former The slag former is assumed to be composed of 50% limestone and 50% bentonite. Coal The data used for coal is litterature data. It is average data from Australia, Poland and USA. Coke The data used for coke production is taken from SSAB Tunnplåt in Luleå, Sweden. Limestone The data used for limestone mining is taken from Nordkalk Storugns on Gotland, Sweden. Bentonite Bentonite is imported from Greece. In this study bentonite mining is approximated to mining of limestone. Transports The following transports are assumed to be standard distances (300 km between the unknown consignor and Fundia Steel AB in Smedjebacken, Sweden), having standard modes of conveyance (road long distance): Scrap, Alloy material, Slag former, Coke and Coal. The data on emissions of particulates from the steel plant is modified according to the particulate composition (taken from the environmental report of Fundia Steel AB): Fe 34% Zn 24,8% Pb 3,0% Ca 2,9% Cu 0,2% Cr 0,2% Ni 0,03 % This equals to 66,15% and the residual, 33,85%, is assumed to be non-metal particulates. The metal emissions are not included in the parameter particulates, but accounted for separatly.
Notes	

SPINE LCI dataset: Seatbelt assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08

Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Seatbelt assembly. Autoliv ESA-DBP
Functional Unit	1 seatbelt
Functional Unit Explanation	1 seatbelt weighs 1129.865 grams
Process Type	Unit operation
Site	Autoliv ALH. Sopronkövesd, Hungary.
Sector	Manufacturing
Owner	Autoliv ALH. Sopronkövesd, Hungary.
Technical system description	The studied seatbelt is installed in Audi A3. The seatbelt with pretensioner retractor is a product which decreases the probability and severity of injury of a driver/passenger during a car crash. It is called active seatbelt and starts its function before a crash through tightening the seatbelt (when driver pushes the break) and releasing the webbing using electrical motor in case that crash is avoided. In case of accident the pyrotechnic charge makes the retractor and buckle pretensioner to tighten the seatbelt and eliminate the space between occupant and the seat rapidly (in 0.01 second). This particular seatbelt weighs 1130 grams and it is mainly made of metals (72%) and plastics (27%). The rest are other materials like chemicals, adhesives, lubricants etc.) The assembly of the seatbelt takes place in Autoliv Hungary and it is done partially manually and with the usage of special equipment. The seatbelt consists of 9 main parts: 1. Pretensioner retractor 2. Webbing pin 3. Webbing guide 4. Webbing 5. Pillar loop 6. Tongue overmoulded 7. Stop button cover 8. Stop button loop 9. Sleeve, data carrier This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is a unit operation. It relates only to the assembly process of 9 subcomponents. Data given by Autoliv in Hungary show that there are emissions to air and water.
Time Boundary	The data were acquired in November 2009, but the energy, water and emissions data come from the year 2008.
Geographical Boundary	The manufacturer is located in Hungary. It was assumed that the energy and water come from the same country.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''

Allocations	The allocation procedure was applicable in case of energy, water and emissions. Those values were given for the annual production. The allocation was done based on the information that half of the resources is used for activities connected with seatbelt production and then allocated according to the operation time.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The input products come from different suppliers from Germany, Turkey, Czech Republic and Belgium.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Comes from Autoliv Stakupress in Germany. The product weighs 79 grams.	Input	Input Product	Pillar loop	1			pce	Technosphere	
Notes: Is assembled in the same plant as the whole seatbelt. The product weighs 759 grams.	Input	Input Product	Pretensioner retractor	1			pce	Technosphere	Hungary
Notes: Comes from the supplier in Germany. The product weighs 6 grams.	Input	Input Product	Sleeve, data carrier	1			pce	Technosphere	
Notes: Comes from the supplier in Germany. The product weighs 6 grams. The product weighs 0.5 gram.	Input	Input Product	Stop button cover	1			pce	Technosphere	
Notes: Comes from the supplier in Germany. The product weighs 0.5 gram.	Input	Input Product	Stop button loop	1			pce	Technosphere	
Notes: Comes from the supplier in Germany. The product weighs 0.5 gram. The product weighs 52.49 grams.	Input	Input Product	Tongue	1			pce	Technosphere	
Notes: Comes from the supplier in Czech Republic. 1 meter of the product weighs 57.8 grams.	Input	Input Product	Webbing	3.77			m	Technosphere	
Notes: Comes from the supplier in Czech Republic. The product weighs 6.3 grams.	Input	Input Product	Webbing guide	1			pce	Technosphere	
Notes: Comes from the supplier in Turkey. The product weighs 2 grams.	Input	Input Product	Webbing pin	1			pce	Technosphere	
	Input	Natural resource	Water	2.53E-01			l	Water	Hungary
	Input	Refined resource	Electricity	3.35E-01			MJ	Technosphere	Hungary
	Input	Resource	Gas	1.85E-01			MJ	Technosphere	Hungary
	Output	Emission	NOx	3.87E-03			g	Air	
	Output	Emission	Particles	4.19E-05			g	Air	
	Output	Emission	SOx	2.89E-04			g	Air	
Notes: Finished seatbelt is transported to Audi production plant	Output	Product	Seatbelt	1			pce	Technosphere	
	Output	Residue	Sludge	2.53E+02			g	Water	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt

	production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the seatbelt should be recycled in a high rate: 69.2% - 71.4% will be recycled and 26.4% recovered as energy. This particular seatbelt was chosen because it was important to have pyrotechnics in it and that it should be representative for more than one model. The studied seatbelt was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's bobbin manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's bobbin manufacturing. Autoliv ESA-DBP
Functional Unit	1 bobbin
Functional Unit Explanation	1 bobbin weighs 101 grams and it is a part of the seatbelt which weighs 1129.865 grams
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The bobbin is a part of the seatbelt and it is located in pretensioner retractor. It is made of alloy and it weighs 101 grams. This particular part is produced in Changshu - Jiangsu in China. The alloy is delivered from Shanghai and it is transported by truck. The manufacturing process consists of the following steps: 1. Quality control 2. Die casting 3. Trimming 4. Burring 5. Cleaning 6. Inspection and packing This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology.

	Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with controlling the materials and ends with packing. Data given by bobbin manufacturer show air emissions but also waste water is produced.
Time Boundary	The data were acquired in October 2009, but the electricity data, other resource and emission data come from the year 2008.
Geographical Boundary	The manufacturer is located in China.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The data were given for the production of this particular part. It was divided by the number of items.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--4.pdf
Notes	The input products come from different suppliers from Germany, Turkey, Czech Republic and Belgium.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	3.40E-01			l	Water	China
	Input	Refined resource	Alloy	1.01E+02			g	Technosphere	China
	Input	Refined resource	Electricity	1.43E+00			MJ	Technosphere	China
	Input	Resource	Gas	6.86E+00			MJ	Technosphere	
Notes: Treated with filter and released to the air	Output	Emission	CO2	3.37E+01			g	Air	
Notes: Treated with filter and released to the air	Output	Emission	NOx	8.82E+00			g	Air	
Notes: Treated with filter and released to the air	Output	Emission	SO2	1.23E+01			g	Air	
Notes: The product weighs 101 grams	Output	Product	Bobbin	1			pce	Technosphere	
Notes: Collected, filtrated, medically treated and transported to treatment plant 10km	Output	Residue	Waste water	3.40E-01			l	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed bobbin is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on above numbers, the bobbin should be recycled in a high rate of 96-99%. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP
Functional Unit	1 car sense ball
Functional Unit Explanation	1 ball weighs 1.65 grams. In one seatbelt twelve of the balls are placed. The total weight of seatbelt is 1129.865 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown

Technical system description	The balls are internal components of the seatbelt. In each studied seatbelt there are 12 balls which are situated in the tube. They are the carriers of the force created by pyrotechnic explosion which is then transfered to the pinion, spindle and webbing in order to tighten the seatbelt just after a crash. They are made of aluminium alloy and each of them weighs 1.65 grams. They are produced in 2 manufacturing plants: in Fulda, Germany and Bouficha, Tunisia and then delivered to Autoliv Hungary. The suppliers of the materials for the second manufacturer (located in Tunisia) are located in US and France and transported by ship. The manufacturing process consists of few steps as followed: 1. Pressing 2. Flashing while defects are removed 3. Polishing 4. Visual inspection 5. Packing This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with processing the alloy and ends with controllong and shipment. Data given by ball, car sense manufacturer show only water emissions but they all are treated.
Time Boundary	The data were acquired in November 2009 and January 2010, but the electricity and waste data come from the year 2008.
Geographical Boundary	Two manufacturing plants are considered: - Fulda, Germany - Bouficha, Tunisia
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Data for resources except electricity and waste were given per 1000 parts. Electricity was given per 1 month and it was possible to calculate since the amount of produced balls per month was known.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using the data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The finished product is transported to Autoliv Hungary

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Aluminium alloy	1.65E+00			g	Technosphere	
	Input	Refined resource	Electricity	5.77E-05			MJ	Technosphere	

	Input	Refined resource	Oil	3.50E-05			l	Technosphere	
Notes: The product weighs 1.65 grams	Output	Product	Car sense ball	1			pce	Technosphere	
Notes: Stored in a specialized treatment centre	Output	Residue	Alu sludge	4.80E+00			g	Technosphere	
Notes: Recycled in a specialized station 120km from the manufacturing plant	Output	Residue	Used oil	9.60E-05			g	Technosphere	
Notes: Recycled in a public recycling plant 60km from the manufacturing plant	Output	Residue	Waste water	3.72E-01			g	Technosphere	

About Inventory	
Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on thevironment.
Detailed Purpose	The discussed ball, car sense is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on above numbers, the car sense ball should be recycled in a high rate of 96-99%. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's frame production. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Seatbelt's frame production. Autoliv ESA-DBP
Functional Unit	1 seatbelt frame
Functional Unit Explanation	1 frame weighs 169.5 grams and it is one of the nine main parts in seatbelt which weighs 1129 grams
Process Type	Gate to gate
Site	Autoliv Stakupress. Norderstedt, Germany.
Sector	Manufacturing
Owner	Autoliv Stakupress. Norderstedt, Germany.
Technical system description	The frame has constructing and housing functions for the pretensioner retractor. The main parts of pretensioner retractor are fastened to it. It is made of steel and it is coated against corrosion. Its weight is 169.5 grams. This kind of frame can be used in many different objects and devices where there is a need for kind of base or framework for the other parts. The product is manufactured in Autoliv Stakupress in Germany. The suppliers of the materials are located in Germany as well. The following steps are included in data set: 1. Fine blanking 2. Vibrator grinding soft 3. Bending 4. Heat treatment (hardening) 5. Vibrator grinding hard 6. Electroplating with Zn 7. Applying passivation layer Zn/ZnNi 8. Annealing The process starts with fine blanking of steel and then grinding. The next step is bending and the result at this stage is a metal blank. The material is then heated and grinded again. After this step the product is electroplated with Zn what consists of defined sequence of galvanic steps without rinsing. Then the passivation layer is applied which is followed by annealing. This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with processing the materials from the suppliers and ends with completing the frame. The data given by frame manufacturer show only water emissions but they all are treated.
Time Boundary	The data were acquired in January 2010, but the electricity data and sale data come from the year 2008.
Geographical Boundary	The manufacturer and its suppliers are located in Germany. It was assumed that the raw materials come from the same country.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of electricity, oil, gas and emissions. Those values were given for the annual production. Allocation was based on the value on annual production and value of studied product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity	5.72E-01			MJ	Technosphere	Germany
	Input	Refined resource	Ni	3E-01			g	Technosphere	Germany
	Input	Refined resource	Oil	2.22E-02			MJ	Technosphere	Germany
	Input	Refined resource	Steel	175.79			g	Technosphere	Germany
	Input	Refined resource	Zn	2.2			g	Technosphere	Germany
	Input	Resource	Gas	1.43E-02			MJ	Technosphere	Germany
Notes: The finished product will be transported to assembly plant in Hungary. The product weighs 169.5 grams.	Output	Product	Metal frame	1			pce	Technosphere	Germany
Notes: Is transported 27km from the plant and physically treated	Output	Residue	Ni	7.54E-04			g	Technosphere	Germany
	Output	Residue	Oil and water emulsion	5.34E-04			g	Technosphere	Germany
	Output	Residue	Scrap	8.35			g	Technosphere	Germany
Notes: Is transported 27km from the plant and physically treated	Output	Residue	Zn	7.85E-03			g	Technosphere	Germany

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed frame is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction.

	Based on above numbers, the frame should be recycled in a high rate of 96-99%. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's gas generator assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's gas generator assembly. Autoliv ESA-DBP
Functional Unit	1 gas generator
Functional Unit Explanation	1 gas generator weighs 11.25 grams and it is a part of seatbelt which weighs 1129.865 grams
Process Type	Unit operation
Site	Autoliv NCS Proto. Survilliers, France.
Sector	Manufacturing
Owner	Autoliv NCS Proto. Survilliers, France.
Technical system description	In the gas generator all the processes responsible for the seatbelt deployment take place. When there is a signal for deployment, the initiator, which is placed in the generator, generates the charge which makes the gas generator release gases in order to tighten the belt and eliminate the space between the seat and the occupant rapidly (on 0.01 second). When the gas generator explodes, released gas pushes the mass boddies (chain of balls) throught the tube what moves the pinion and spindle. As a result, the belt is tightened. The gas generator is assembled in Autoliv France and then transported and installed into the sealtbelt's short tube in Autoliv Hungary. It weighs 11.25 grams. The assembly is done partially manually and with the usage of special equipment. It consists of following parts: 1. Holder 2. Shunt ring 3. Sealant, omnifit 4. O-ring 5. Initiator serviceable 6. Cap 7. Propellants 8. Bar code This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP

	- Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is a unit operation. It relates to assembling of 8 subcomponents. Data given by gas generator manufacturer do not show any emissions. Only the scrap is produced.
Time Boundary	Some of the data were collected in December 2009 and the rest in March 2010. Data for water, gas and electricity come from the year 2008.
Geographical Boundary	The manufacturer is located in France.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Data given per 1 product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: The product weighs 0.001 gram	Input	Input Product	Bar code	1			pce	Technosphere	France
Notes: The product weighs 1.85 grams	Input	Input Product	Cap	1			pce	Technosphere	France
Notes: The product weighs 3.119 grams	Input	Input Product	Holder	1			pce	Technosphere	France
Notes: The product weighs 4.1248 grams	Input	Input Product	Initiator serviceable	1			pce	Technosphere	France
Notes: The product weighs 0.1gram	Input	Input Product	O-ring	1			pce	Technosphere	France
	Input	Input Product	Propellants	1.00E+00			g	Technosphere	France
	Input	Input Product	Sealant, omnifit	1.00E+00			g	Technosphere	France
Notes: The product weighs 0.45 gram	Input	Input Product	Shunt ring	1			pce	Technosphere	France
	Input	Natural resource	Water	6.60E-01			l	Water	France
	Input	Refined resource	Electricity	5.76E-01			MJ	Technosphere	France
	Input	Resource	Gas	4.20E+00			MJ	Technosphere	France
Notes: The product weighs 11.25 grams	Output	Product	Gas generator	1			pce	Technosphere	France
Notes: Some part of it is burnt and the metal scrap is sold.	Output	Residue	Scrap	9.00E-02			g	Technosphere	France

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed gas generator is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt

	production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the metal parts of gas generator should be recycled in a high rate of 96-99%. Plastic parts will be recovered as energy. The seatbelt will be deployed before shredding, so the explosive materials but also oxidizers will be released as the gases during this process. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's header manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's header manufacturing. Autoliv ESA-DBP
Functional Unit	1 header
Functional Unit Explanation	1 header weighs 1.9174 grams and it is a part of seatbelt which weighs 1129.865 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The header is a part of seatbelt produced by Autoliv. It is placed in a pretensioner retractor and it is mainly made of steel, ceramic and NiFe alloy. The product weighs 1.92 gram. The manufacturing plant is located in Lan Skroun, Czech Republic and the ready product is then transported to Autoliv in France. The manufacturing process starts with casting and then the cast is coated and plated with respectively gold and nickel. This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP

	- Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with shaping the product and ends with coating and plating. Data given by header manufacturer show that there is no emissions to environment.
Time Boundary	The data were acquired in September 2009, but the electricity data and sale data come from the year 2008.
Geographical Boundary	The manufacturer is located in Czech Republic.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Allocation procedure for electricity and water was done based on value of total sale and value of single product. The rest of data were given per 1 product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	2.83E-05			l	Technosphere	
	Input	Refined resource	Au	1.00E-02			g	Technosphere	
	Input	Refined resource	Ceramic	4.17E-01			g	Technosphere	
	Input	Refined resource	Electricity	1.64E-05			MJ	Technosphere	Czech Republic
	Input	Refined resource	Nickel	3.16E-02			g	Technosphere	
	Input	Refined resource	NiFe 47	4.52E-01			g	Technosphere	
	Input	Refined resource	Special metal	2.80E-02			g	Technosphere	
	Input	Refined resource	Steel	9.79E-01			g	Technosphere	
Notes: The finished product is transported to Autoliv in France. The product weighs 1.92 grams.	Output	Product	Header	1			pce	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf

Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed header is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Arief Mujiyanto & Susetyo Priyojati - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the header should be recycled in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's initiator, serviceable assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's initiator, serviceable assembly. Autoliv ESA-DBP
Functional Unit	1 initiator serviceable
Functional Unit Explanation	1 initiator serviceable weighs 4.1248 grams and it is a part of seatbelt which weighs 1129.865 grams
Process Type	Unit operation
Site	Autoliv NCS Proto. Survilliers, France.
Sector	Manufacturing
Owner	Autoliv NCS Proto. Survilliers, France.
Technical system description	The initiator is a part of the seatbelt and it is responsible for generating the charge which makes a gas generator to be activated. In case of accident the pyrotechnic charge makes the retractor and buckle pretensioner tighten the seatbelt and eliminates the space between the seat and the occupant rapidly (in 0.01 second). Initiator is assembled in Autoliv in France and then installed in gas generator in the same plant. It weighs 4.12 grams.

	The assembly is done partially manually and with the usage of special equipment. It consists of the following components: 1. Initiator overmolding 2. Header 3. PCB 4. Solder paste lead free 5. Solder paste alfafree 6. Paste 7. Powder 8. Loaded cup 9. O-ring 10. Cover This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is a unit operation. It relates to the assembling of 10 subcomponents. Data given by initiator serviceable manufacturer do not show any emissions.
Time Boundary	The data were acquired in December 2009, but the electricity data and other resources data come from the year 2008.
Geographical Boundary	The manufacturer is located in France.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Data were given per 1 product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: The weight fo the product is 0.1 grams	Input	Input Product	Cover	1			pce	Technosphere	
Notes: The weight fo the product is 1.9174 grams	Input	Input Product	Header	1			pce	Technosphere	
Notes: The weight fo the product is 0.418 grams	Input	Input Product	Initiator overmoulding	1			pce	Technosphere	
Notes: The weight fo the product is 0.575 grams	Input	Input Product	Loaded cup	1			pce	Technosphere	

Notes: The weight fo the product is 0.0327 grams	Input	Input Product	O-ring	1			pce	Technosphere	
	Input	Input Product	Paste	1.70E-02			g	Technosphere	
Notes: The weight fo the product is 0.009675 grams	Input	Input Product	PCB	1			pce	Technosphere	
	Input	Input Product	Powder	4.50E-02			g	Technosphere	
	Input	Input Product	Solder paste 1	1.00E-01			g	Technosphere	
	Input	Input Product	Solder paste 2	1.00E+00			g	Technosphere	
	Input	Natural resource	Natural gas	3.04E+00			MJ	Technosphere	
	Input	Natural resource	Water	4.78E-01			l	Water	France
	Input	Refined resource	Electricity	4.17E-01			MJ	Technosphere	France
Notes: The weight fo the product is 4.1248 grams. Initiator is installed in gas generator.	Output	Product	Initiator serviceable	1			pce	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed initiator, serviceable is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the initiator should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's label bam manufacturing. Autoliv ESA-DBP

Administrative

Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Seatbelt's label bam manufacturing. Autoliv ESA-DBP
Functional Unit	1 label bam
Functional Unit Explanation	1 label bam weighs 0.22 gram and it is a part of the seatbelt which weighs 1129.865 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	This particular label bam is a data carrier which is put on the seatbelt installed in Audi A3. It is made of polyester and paper and weighs 0.22 gram. It is manufactured in the plant in Oberschleißheim, Germany and then put on the seatbelt during its assembling. The manufacturing process consists of following steps: 1. Preparing the material 2. Die cutting 3. Printing on pressure sensitive material The result of the manufacturing process are labels on roll. This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with preparing the materials and ends with printing and reeling in the roll. Data given by label bam manufacturer show air and water emissions. Some waste is also produced.
Time Boundary	The data were acquired in March 2010.
Geographical Boundary	The manufacturer is located in Oberschleißheim, Germany.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The data were given per 1 product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010

Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Water	4.00E-03			l	Water	
	Input	Refined resource	Adhesive	3.60E-02			g	Technosphere	
	Input	Refined resource	Cleaning solution	3.00E-03			g	Technosphere	
	Input	Refined resource	Electricity	7.20E-02			MJ	Technosphere	
	Input	Refined resource	Ink	8.00E-03			g	Technosphere	
	Input	Refined resource	Paper board core	1.50E-02			g	Technosphere	
	Input	Refined resource	Polyester	1.06E-01			g	Technosphere	
	Input	Refined resource	Release paper	1.12E-01			g	Technosphere	
	Input	Resource	Gas	6.84E-02			MJ	Technosphere	
	Output	Emission	Solvents to the air	5.00E-03			g	Air	
	Output	Emission	Waste water	2.00E-03			l	Water	
Notes: The product weighs 0.22 grams	Output	Product	Label bam	1			pce	Technosphere	
Notes: To be thermally combusted.	Output	Residue	Liquid hazardous waste	1.00E-03			g	Technosphere	
Notes: To be thermally recycled	Output	Residue	Solid label waste	6.00E-02			g	Technosphere	
Notes: To be recycled	Output	Residue	Solid paper waste	2.00E-02			g	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed label bam is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).

Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the label bam should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt’s pillar loop production. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt’s pillar loop production. Autoliv ESA-DBP
Functional Unit	1 pillar loop
Functional Unit Explanation	1 pillar loop weighs 79 grams and it is one of the nine main parts in the seatbelt which weighs 1129 grams
Process Type	Gate to gate
Site	Autoliv Stakupress. Norderstedt, Germany.
Sector	Manufacturing
Owner	Autoliv Stakupress. Norderstedt, Germany.
Technical system description	The pillar loop is a part of the seatbelt and has the anchor function for seatbelt. The studied seatbelt is 3 points type and one of these points is created by pillar loop. The webbing passes through it when the belt is adjusted. The product is manufactured in Autoliv Stakupress in Germany and then it is transported to Autoliv Hungary. It consists of steel which is coated against corrosion and the plastics which is overmoulded. The following steps are included in data set: 1. Stamping 2. Vibrator grinding 3. Heat treatment 4. Vibrator grinding II 5. Zinc flakes coating 6. Top coat 7. Overmoulding The process starts with oil stamping and grinding of raw material (steel C60). The steel is then heated and grinded again. After this step the part is coated with zinc flakes and in the end overmoulded with plastics (polyoximethylene). This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv’s front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt’s car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt’s bobbin manufacturing. Autoliv ESA-DBP - Seatbelt’s frame production. Autoliv ESA-DBP - Seatbelt’s gas generator assembly. Autoliv ESA-DBP - Seatbelt’s polyamide granules production. Autoliv ESA-DBP - Seatbelt’s header manufacturing. Autoliv ESA-DBP - Seatbelt’s initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt’s label bam manufacturing. Autoliv ESA-DBP - Seatbelt’s pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt’s rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt’s short tube assembly. Autoliv ESA-DBP - Seatbelt’s solder paste manufacturing. Autoliv ESA-DBP - Seatbelt’s spindle assembly. Autoliv ESA-DBP - Seatbelt’s spring antiretour manufacturing. Autoliv ESA-DBP

	- Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with processing the materials from the suppliers and ends with completing the pillar loop. Data given by the pillar loop manufacturer show only water emissions but they all are treated.
Time Boundary	The data were acquired in January 2010, but the electricity data and sale data come from the year 2008.
Geographical Boundary	The manufacturer and its suppliers are located in Germany. It was assumed that the raw materials come from the same country.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintanance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of electricity, oil, gas and emissions. Those values were given for the annual production. Allocation was based on the value of annual production and value of studied product. The rest of the factors (materials) were given per product so the allocation was not needed.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Natural gas	1.43E-02			MJ	Technosphere	Germany
	Input	Refined resource	Electricity	5.72E-01			MJ	Technosphere	Germany
	Input	Refined resource	Oil	2.22E-02			MJ	Technosphere	Germany
Method: Collected data were given per 1 product	Input	Refined resource	Polyoximethylene	19			g	Technosphere	Germany
Method: Collected data were given per 1 product	Input	Refined resource	Steel	61.2			g	Technosphere	Germany
Method: Collected data were given per 1 product	Input	Refined resource	Top coat	9.34E-02			g	Technosphere	Germany
Method: Collected data were given per 1 product	Input	Refined resource	Zinc flakes	2.22E-01			g	Technosphere	Germany
Notes: Is transported 27km from the plant and physically treated	Output	Emission	Chromium	7.54E-04			g	Water	Germany
Notes: Is transported 27km from the plant and physically treated	Output	Emission	Cu	7.54E-04			g	Water	Germany
Notes: Is transported 27km from the plant and chemically treated	Output	Emission	Cyanide	3.47E-05			g	Water	Germany
Notes: Is transported 27km from the plant and physically treated	Output	Emission	Ni	6.09E-04			g	Water	Germany
Notes: Is transported 27km from the plant and physically treated	Output	Emission	Zn	5.8E-04			g	Water	Germany
Notes: The ready product is transported to assembly plant which is located in Hungary. It is followed by the 'Assembly of seatbelt'. The product weighs 79 grams.	Output	Product	Pillar loop	1			pce	Technosphere	Germany
Notes: Is separated and refined	Output	Residue	Oil and water emulsion	8.46E-03			g	Technosphere	Germany
	Output	Residue	Scrap	1.61			g	Technosphere	Germany
Notes: Is transported 130km from the plant and physically treated	Output	Residue	Used oil	5.88E-04			g	Technosphere	Germany

About Inventory	
Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform four LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed pillar loop is a part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of the seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicabilty for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the pillar loop should be recovered in a high rate of 96-99%. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's polyamide granules production. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's polyamide granules production. Autoliv ESA-DBP
Functional Unit	1kg of granules
Functional Unit Explanation	For the studied seatbelt 0.418 grams of granules is needed.
Process Type	Unit operation
Site	Unknown
Sector	Manufacturing

Owner	Unknown
Technical system description	Polyamide granules are the part of initiator overmolding which is located in the seatbelt. They consist of polyamide 66 and glass fibre. Granules are manufactured in the plant which is located in Plaisir, France. The granules are manufactured through extrusion process and then transported to Autoliv plant in France. This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is a unit operation. It consists of thermoplastic extrusion. Data given by granules manufacturer show only waste which are then landfilled or reused and recycled.
Time Boundary	The data were acquired in November 2009, but the resources and waste data come from the year 2008.
Geographical Boundary	The manufacturing plant is located in Plaisir, France.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included''
Allocations	The data given by the supplier were expressed in values per kg, so the allocation procedure was not needed.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	2.88E+00			MJ	Technosphere	France
	Input	Refined resource	Glass fibre	3.50E+02			g	Technosphere	Malaysia
	Input	Refined resource	LPG	1.32E-01			MJ	Technosphere	
	Input	Refined resource	Methane	2.15E+02			MJ	Technosphere	
	Input	Refined resource	Polyamide 66 (PA66)	6.50E+02			g	Technosphere	Italy
	Output	Product	Polyamide granules	1.00E+03			g	Technosphere	France
Notes: Landfilled	Output	Residue	Municipal waste	8.00E+00			g	Technosphere	

Notes: Landfilled	Output	Residue	Specific production waste	1.60E+01			g	Technosphere	
Notes: Reused and recycled within the plant	Output	Residue	Wood/paper	2.70E+01			g	Technosphere	

About Inventory	
Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed granules are the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP
Functional Unit	1 pretensioner retractor
Functional Unit Explanation	1 pretensioner retractor weighs 759.292 grams and it is a part of the seatbelt which weighs 1129.865 grams
Process Type	Unit operation
Site	Autoliv ALH. Sopronkövesd, Hungary.
Sector	Manufacturing

Owner	Autoliv ALH. Sopronkövesd, Hungary.
Technical system description	Pretensioner retractor is a part of a seatbelt that is responsible for tightening the belt and eliminating the slack between the occupant and seat just after a crash. The retraction is initiated by the signal from the car sensors after a crash occurs. Then the initiator creates the charge which makes gas generator explode. The emitted gas pushes the mass boddies (chain of the balls) which cause the movement of the pinion and connected with it spindle. Spindle is directly attached to the webbing so the result of this process is that the belt is tightened. The assembly of the pretensioner retractor takes place in Autoliv Hungary and it is done partially manually and with the usage of special equipment. The pretensioner retractor consists of 15 main parts: 1. Frame 2. Collector 3. Guide ball 4. Rivet blindniet 5. Tube 6. Cover 1 7. Cover 2 8. Rivet nut 9. Spindle 10. Web sensor 11. Bearing plate 12. Car sensor 13. Ball for car sensor 14. Cap 15. Identification label 16. Label This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is a unit operation. It relates only to the assembly process of 16 subcomponents. Data given by Autoliv in Hungary show that there are emissions to air and water.
Time Boundary	The data were acquired in November 2009, but the energy, water and emissions data come from the year 2008.
Geographical Boundary	The manufacturer is located in Hungary. It was assumed that the energy and water come from the same country.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of energy, water and emissions. Those values were given for the annual production. The allocation was done based on the information that half of the resources is used for activities connected with seatbelt production and then allocated according to the operation time.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.

Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Manufactured in Konjice, Slovenia. The product weighs 9 grams.	Input	Input Product	Cap	1			pce	Technosphere	
Notes: Manufactured in Hodenhagen, Germany. The product weighs 9 grams.	Input	Input Product	Car sensor	1			pce	Technosphere	
Notes: Manufactured in Krnov, Czech Republic. The product weighs 27.3 grams.	Input	Input Product	Collector	1			pce	Technosphere	
Notes: Manufactured in Mörfeden-Walldorf, Germany. The product weighs 125 grams.	Input	Input Product	Cover 1	1			pce	Technosphere	
Notes: Manufactured in Bencovac, Croatia, transported to Mörfeden-Walldorf, Germany and then to Autoliv Hungary. The product weighs 6.16 grams.	Input	Input Product	Cover 2	1			pce	Technosphere	
Notes: Manufactured in Hodenhagen, Germany. The product weighs 6.5 grams.	Input	Input Product	Guide ball	1			pce	Technosphere	
Notes: Manufactured in Salzgitter, Germany. The product weighs 0.095 gram.	Input	Input Product	Identification label	1			pce	Technosphere	
Notes: Manufactured in Hosena, Germany. The product weighs 0.095 gram.	Input	Input Product	Label	1			pce	Technosphere	
Notes: Manufactured in Autoliv Stakupress, Germany. The product weighs 169.5 grams.	Input	Input Product	Metal frame	1			pce	Technosphere	
Notes: manufactured in plant in Austria. The product weighs 3.197 grams.	Input	Input Product	Rivet blidniet	1			pce	Technosphere	
Notes: Is manufactured in Reinbek, Germany. The product weighs 3.211 grams.	Input	Input Product	Rivet nut	2			pce	Technosphere	
Notes: Is manufactured in the same plant as pretensioner retractor. The product weighs 136.78 grams.	Input	Input Product	Short tube	1			pce	Technosphere	
Notes: Is manufactured in the same place as pretensioner retractor. The product weighs 229.92 grams.	Input	Input Product	Spindle	1			pce	Technosphere	
	Input	Natural resource	Water	1.04E-01			l	Water	Hungary
Notes: It was assumed that the electricity is produced in Hungary	Input	Refined resource	Electricity	1.38E-01			MJ	Technosphere	Hungary
	Input	Resource	Gas	7.61E-02			MJ	Technosphere	Hungary
	Output	Emission	NOx	1.59E-03			g	Air	
	Output	Emission	Particulates	1.72E-05			g	Air	
	Output	Emission	SOx	1.19E-04			g	Air	
Notes: The product weighs 756 grams.	Output	Product	Pretensioner retractor	1			pce	Technosphere	
	Output	Residue	Sludge	1.04E+02			g	Water	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed pretensioner retractor is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming

	potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the pretensioner retractor should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP
Functional Unit	1 rivet nut
Functional Unit Explanation	1 rivet nut weighs 3.21 grams and it is a part of the seatbelt which weighs 1129.865 grams
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Rivet nuts are used for fastening the components of the seatbelt. In the studied seatbelt there are 2 of them and are located in pretensioner retractor. The length of each is 23.8 mm and the weight is 3.21 grams. They are made of steel and then coated with zinc. Rivet nut is produced in the plant in Germany and then transported to Autoliv Hungary. The steps connected with manufacturing process are as followed: 1. Pressing 2. Coating 3. Washing 4. Packing 5. Transport 6. Sorting (with the machine) 7. Dispatch This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP

- Seatbelt's bobbin manufacturing. Autoliv ESA-DBP
- Seatbelt's frame production. Autoliv ESA-DBP
- Seatbelt's gas generator assembly. Autoliv ESA-DBP
- Seatbelt's polyamide granules production. Autoliv ESA-DBP
- Seatbelt's header manufacturing. Autoliv ESA-DBP
- Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP
- Seatbelt's label bam manufacturing. Autoliv ESA-DBP
- Seatbelt's pillar loop production. Autoliv ESA-DBP
- Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP
- Seatbelt assembly. Autoliv ESA-DBP
- Seatbelt's short tube assembly. Autoliv ESA-DBP
- Seatbelt's solder paste manufacturing. Autoliv ESA-DBP
- Seatbelt's spindle assembly. Autoliv ESA-DBP
- Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP
- Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP
- Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP
- Seatbelt's tongue production. Autoliv ESA-DBP
- Seatbelt's tube manufacturing. Autoliv ESA-DBP
- Seatbelt's web sensor manufacturing. Autoliv ESA-DBP
- Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with shaping the product and ends with dispatching. Data given by rivet nut manufacturer show that there is no emissions during the process. Only scrap is produced.
Time Boundary	The data were acquired in December 2009, but they come from the year 2008.
Geographical Boundary	The manufacturer is located in Germany.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study.''
Allocations	The data for electricity were given per number of produced items.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	For the studied seatbelt 2 rivet nuts are needed. During the process electricity for washing is used. However the supplier have given specific data for it.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Alloy material	2.00E-01			g	Technosphere	
	Input	Refined resource	Electricity	3.38E-03			MJ	Technosphere	Germany
	Input	Refined resource	Electricity for sorting	4.50E-04			MJ	Technosphere	
	Input	Refined resource	Steel	3.16E+00			g	Technosphere	
	Input	Refined resource	Zinc	1.10E-02			g	Technosphere	
	Output	Product	Rivet nut	3.21E+00			g	Technosphere	
	Output	Residue	Scrap	1.58E-01			g	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed rivet nut is a part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most

	4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the rivet nut should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's short tube assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's short tube assembly. Autoliv ESA-DBP
Functional Unit	1 short tube
Functional Unit Explanation	1 short tube weighs 136.7791 grams and it is a part of seatbelt which weighs 1129.865 grams
Process Type	Unit operation
Site	Autoliv ALH. Sopronkövesd, Hungary.
Sector	Manufacturing
Owner	Autoliv ALH. Sopronkövesd, Hungary.
Technical system description	The short tube is a crucial part of the studied seatbelt. It is placed in pretensioner retractor and all the processes connected with pyrotechnics take place there. In case of accident the pyrotechnic charge makes the pretensioner retractor tighten the seatbelt and eliminate the space between occupant and the seat rapidly (on 0.01 second). The tube is ended with gas generator. When there is a signal from the sensors in the car, the initiator in gas generator creates the charge to make gas generator explode. The gas is released under the high pressure and pushes the mass bodies (chain of balls) through the tube. That moves the pinion and spindle which is attached to the webbing. The assembly of the short tube takes place in Autoliv Hungary and it is done partially manually and with the usage of special equipment. It consists of 9 main parts: 1. Ball synchronization 2. Snap-in-faster 3. Identification label 4. Tube 5. Compression spring 6. Ball, car sense x 12 7. Piston 8. Antiretour spring 9. Gas generator

	This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is a unit operation. It relates to assembly process of 9 components. Data given by short tube manufacturer show air and water emissions.
Time Boundary	The data were acquired in November 2009, but the energy, water and emissions data come from the year 2008.
Geographical Boundary	The manufacturer is located in Hungary. It was assumed that the energy and water come from the same country.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of energy, water and emissions. Those values were given for the annual production. The allocation was done based on the information that half of the resources is used for activities connected with seatbelt production and then allocated according to the operation time.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	For the studied seatbelt 2 rivet nuts are needed. During the process electricity for washing is used. However the supplier have given specific data for it.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Produced in Fulda, Germany and Bouficha, Tunisia. The product weighs 19.8 grams.	Input	Input Product	Car sense ball	12			pce	Technosphere	
Notes: Produced in Autoliv France. The product weighs 11.2 grams	Input	Input Product	Gas generator	1			pce	Technosphere	
Notes: Produced in Einbeck, Germany. The product weighs 0.2 grams	Input	Input Product	Identification label	1			pce	Technosphere	
Notes: Produced in Gelnhausen, Germany. The product weighs 0.84 gram	Input	Input Product	Piston	1			pce	Technosphere	
Notes: Produced in München, Germany. The product weighs 0.2 grams	Input	Input Product	Snap-in-fastner	1			pce	Technosphere	
Notes: Produced in Lichtenstein, Germany. The product weighs 0.28 gram.	Input	Input Product	Spring antiretour	1			pce	Technosphere	

Notes: Produced in France and USA. The product weighs 0.37 grams	Input	Input Product	Spring compression	1			pce	Technosphere	
Notes: Produced in Bursa, Turkey. The product weighs 6.34 grams	Input	Input Product	Synchronization ball	1			pce	Technosphere	
Notes: Produced in Düsseldorf, Germany. The product weighs 97.5 grams	Input	Input Product	Tube	1			pce	Technosphere	
	Input	Natural resource	Water	5.30E-03			MJ	Water	Hungary
	Input	Refined resource	Electricity	7.03E-03			MJ	Technosphere	Hungary
	Input	Resource	Gas	3.88E-03			MJ	Technosphere	
	Output	Emission	NOx	8.11E-05			g	Air	
	Output	Emission	Sludge	5.30E+00			g	Water	
	Output	Emission	SOx	6.06E-06			g	Air	
	Output	Emission	Susp solids	8.78E-07			g	Air	
Notes: Finished product will be assembled into pretensioner retractor	Output	Product	Short tube	1.36E+02			g	Technosphere	

About Inventory	
Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed short tube is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the short tube should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's solder paste manufacturing. Autoliv ESA-DBP

Administrative

Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Seatbelt's solder paste manufacturing. Autoliv ESA-DBP
Functional Unit	1kg of paste
Functional Unit Explanation	For 1 analyzed seatbelt the paste is needed in amount of 0.12 grams. The seatbelt weighs 1129.865 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Solder paste is used for manufacturing the gas generator which is the important part in the particular seatbelt produced by Autoliv. It is used for fastening some small components. In the analyzed paste, the alloy consists of Sn, Pb and Ag. The paste is manufactured in the plants which are located in Cholet, France and St Priest, France and then is transported to Autoliv in France. The manufacturing process consists of following steps: 1. Atomisation of metal 2. Sieving 3. Blending with flux 4. Filling the syringe This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with atomising the metals and ends with filling in the syringe. Data given by one of the manufacturers show that there are air emissions and also toxic solid waste is produced.
Time Boundary	The data were acquired in January 2010, but the data come from 2008.
Geographical Boundary	The supplier no. 1 of which the data are used is located in Cholet, France and the other one is in St Priest, France.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The data about the content were given per product. The rest of the data was given for the whole production and then the number of items and its weight were given as well.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The finished product is transported to Autoliv in France

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Input Product	Syringe	1			pce	Technosphere	
	Input	Natural resource	Water	5.00E+00			l	Technosphere	France
	Input	Refined resource	Ag	1.78E+01			g	Technosphere	
	Input	Refined resource	Electricity	4.68E-01			MJ	Technosphere	France
	Input	Refined resource	Flux	8.70E+02			g	Technosphere	
	Input	Refined resource	Pb	3.22E+02			g	Technosphere	
	Input	Refined resource	Sn	5.53E+02			g	Technosphere	
Notes: Data reporter notes: Value reliability questioned. Value as reported in reference	Output	Emission	Ag	1.12E+01			g	Air	
Notes: Data reporter notes: Value reliability questioned. Value as reported in reference	Output	Emission	CO2	2.16E+04			g	Air	
Notes: Data reporter notes: Value reliability questioned. Value as reported in reference	Output	Emission	Dust	2.98E+01			g	Air	
Notes: Data reporter notes: Value reliability questioned. Value as reported in reference	Output	Emission	Pb	1.12E+01			g	Air	
Notes: Data reporter notes: Value reliability questioned. Value as reported in reference	Output	Emission	Sn	5.44E+00			g	Air	
	Output	Product	Solder paste 1	1.00E+03			g	Technosphere	
Notes: The waste is incinerated.	Output	Residue	Solid toxic waste	4.27E+03			g	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed solder paste is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis.

	Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's spindle assembly. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's spindle assembly. Autoliv ESA-DBP
Functional Unit	1 spindle
Functional Unit Explanation	1 spindle weighs 230 grams and it is a part of the seatbelt which weighs 1129.865 grams.
Process Type	Unit operation
Site	Autoliv ALH. Sopronkövesd, Hungary.
Sector	Manufacturing
Owner	Autoliv ALH. Sopronkövesd, Hungary.
Technical system description	The spindle is a part of the studied seatbelt and it is located in a pretensioner retractor. It is a part of the mechanism which adjusts the tension of the belt. When a crash occurs, gas generator emits a gas under the high pressure which pushes mass bodies (chain of balls) through the tube and causes the move of the pinion which is connected with the spindle. The result is that the belt is retracted and the space between the occupant and the seat is eliminated what decreases the probability and severity of the injury. The spindle is assembled in Autoliv Hungary and then fastened into pretensioner retractor and seatbelt in the end. The weight of this product is 230 grams. The assembly of the spindle is done partially manually and with the usage of special equipment. It consists of: 1. Safety plate 2. Spring wire 3. Gear wheel 4. Tread head 5. Bar torsion 6. Bobbin mirror 7. Gear ring 8. Bar code This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP

	- Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is a unit operation. It relates only to the assembly process of 8 subcomponents. Data given by Autoliv Hungary show that there are emissions to air and water.
Time Boundary	The data were acquired in November 2009, but the energy, water and emissions data come from the year 2008.
Geographical Boundary	The manufacturer is located in Hungary.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of energy, water and emissions. Those values were given for the annual production. The allocation was done based on the information that half of the resources is used for activities connected with seatbelt production and then allocated according to the operation time.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The finished product is transported to Autoliv in France

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: The product weighs 0.9 gram	Input	Input Product	Bar code	1			pce	Technosphere	
Notes: The product weighs 38 grams	Input	Input Product	Bar torsion	1			pce	Technosphere	
Notes: The product weighs 101 grams	Input	Input Product	Bobbin	1			pce	Technosphere	
Notes: The product weighs 36 grams	Input	Input Product	Gear ring	1			pce	Technosphere	
Notes: The product weighs 8 grams	Input	Input Product	Gear wheel	1			pce	Technosphere	
Notes: The product weighs 2 grams	Input	Input Product	Safety plate	1			pce	Technosphere	
Notes: The product weighs 3.211 grams	Input	Input Product	Spring, wire	1			pce	Technosphere	
Notes: 40.8 grams	Input	Input Product	Tread head	1			pce	Technosphere	
	Input	Natural resource	Water	1.03E-02			l	Water	
	Input	Refined resource	Electricity	1.36E-02			MJ	Technosphere	Hungary
	Input	Refined resource	Gas	7.51E-03			MJ	Technosphere	
	Output	Emission	NOx	1.63E-03			g	Air	
	Output	Emission	Sludge	1.06E+02			g	Water	
	Output	Emission	SOx	1.22E-04			g	Air	
	Output	Emission	Susp solids	1.76E-05			g	Air	
Notes: The product weighs 230 grams and it is then assembled into pretensioner retractor and seatbelt in the end.	Output	Product	Spindle	1			pce	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf

Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed spindle is a part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the spindle should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP
Functional Unit	1 spring antiretour
Functional Unit Explanation	1 spring antiretour weighs 0.28 grams whereas seatbelt itself weighs 1129.865 grams
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The spring antiretour is a part of the seatbelt. It is placed in pretensioner retractor. The studied spring weighs 0.28 gram and it is made of stainless steel. The spring antiretour is manufactured in the plant in Lichtenstein, Germany. The manufacturing process consists of followed steps: 1. Material control

	2. Manufacturing 3. Cleaning 4. Heat treatment 5. Packing/dispatch This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with controlling the materias and ends with packing and dispatching the finished products. Data given by spring antiretour manufacturer show only scrap production - no emissions were detected.
Time Boundary	The data were acquired in January 2010, but the electricity data come from the year 2008.
Geographical Boundary	The manufacturer is located in Germany.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The data given were per 1 product so there was no need for allocation.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The finished product is transported to Autoliv in France

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	6.27E-03			MJ	Technosphere	Germany
Notes: Supplied from Hagen, Germany	Input	Refined resource	Stainless steel	2.95E-01			g	Technosphere	
Notes: Finished product will be transported to Autoliv Hungary	Output	Product	Spring antiretour	2.80E-01			g	Technosphere	
Notes: Recycled by the plant placed 85km from the manufacturing plant	Output	Residue	Stamping waste (metal)	4.00E-02			g	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf

Intended User	LCA practinioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed spring antiretour is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the spring antiretour should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP
Functional Unit	1 spring, wire
Functional Unit Explanation	1 spring wire weighs 0.21 gram and it is a part of seatbelt which weighs 1129.865 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	This particular spring wire is used in pretensioner retractor in seatbelt. It is produced in 2 manufacturing plants. First is located in Beuren, Germany and the other one in Lichtenstein, Germany. The spring wire is made of stainless steel and it weighs 0.21 gram. The manufacturing process consists of the following steps: 1. Receipt of material

	2. Manufacturing 3. Cleaning 4. Heat treatment 5. Packing/dispatch This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF:http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with shaping the material and ends with dispatching. Data given by spring wire manufacturers do not show any emissions. Only scrap is produced.
Time Boundary	The data were acquired in December 2009, but the data come from the year 2008.
Geographical Boundary	The manufacturers are located in Germany.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Data were given per 1 product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--4.pdf
Notes	Data come from supplier in Beuren, Germany

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	2.88E-03			MJ	Technosphere	Germany
	Input	Refined resource	Stainless steel	2.20E-01			MJ	Technosphere	Germany
Notes: Thw weight of the product is 0.21 gram	Output	Product	Spring, wire	1			pce	Technosphere	Germany
	Output	Residue	Scrap	1.15E-02			g	Technosphere	Germany

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner

General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed wire spring is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the spring wire should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP
Functional Unit	1 synchronization ball
Functional Unit Explanation	1 synchronization ball weighs 6.34 grams and it is a part of seatbelt which weighs 1129.865 grams
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The synchronization ball is a part of the seatbelt and it is located in pretensioner retractor. It is made of zinc alloy and its weight is 6.34 grams. It is produced in Bursa, Turkey and Lake Forest-CA-US and then transported to Autoliv Hungary. The steps in the production process are as followed: 1. Inspection of the materials 2. Casting 3. Drying

	4. Separation 5. Control 6. Packing This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with inspection of the materials, through production and ends with final control, packing and shipping. Data given by ball synchronization manufacturer show that there are no emissions during the process.
Time Boundary	The data were acquired in November 2009, but they come from the year 2008.
Geographical Boundary	The manufacturer is located in Turkey.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Data given by the supplier were already calculated per 1 functional unit.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	Data come from supplier in Beuren, Germany

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	2.58E-02			MJ	Technosphere	Turkey
	Input	Refined resource	Lubricant oil	3.00E-01			g	Technosphere	Turkey
	Input	Refined resource	Zinc alloy	6.50E+00			g	Technosphere	
Notes: The finished product is transported to Autoliv Hungary	Output	Product	Synchronization ball	6.34E+00			g	Technosphere	
	Output	Residue	Scrap	4.00E-1			g	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf

Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed synchronization ball is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the synchronization ball should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's tongue production. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's tongue production. Autoliv ESA-DBP
Functional Unit	1 tongue
Functional Unit Explanation	1 tongue weighs 52,493 grams and it is one of the nine main parts in seatbelt which weighs 1129.865 grams
Process Type	Gate to gate
Site	Autoliv Stakupress. Norderstedt, Germany.
Sector	Manufacturing
Owner	Autoliv Stakupress. Norderstedt, Germany.
Technical system description	The tongue is a part of the seatbelt which is responsible for locking the seatbelt into the buckle. It is made of coated steel and it is overmoulded with plastics. It represents the average tongue used for seatbelts. The product is manufactured in Autoliv Stakupress in Germany. The following steps are included in data set:

1. Fine blanking
2. Vibrator grinding soft
3. Bending
3. Heat treatment (hardening)
4. Vibrator grinding hard
5. Electroplating Cu Ni Cr
6. Annealing
7. Overmoulding

The process starts with fine blanking of steel and then grinding. The next step is a bending and the result at this stage is a metal blank. The material is then heated and grinded again. After this step the product is electroplated with Cu, Ni and Cr what consists of 11 galvanic steps without rinsing. In the end the product is overmoulded with plastics (polyoximethylene).

This process is included in the system described in:
Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden.
Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf

Other processes in the CPM Database also included in the above publication:
- Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP
- Seatbelt's bobbin manufacturing. Autoliv ESA-DBP
- Seatbelt's frame production. Autoliv ESA-DBP
- Seatbelt's gas generator assembly. Autoliv ESA-DBP
- Seatbelt's polyamide granules production. Autoliv ESA-DBP
- Seatbelt's header manufacturing. Autoliv ESA-DBP
- Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP
- Seatbelt's label bam manufacturing. Autoliv ESA-DBP
- Seatbelt's pillar loop production. Autoliv ESA-DBP
- Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP
- Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP
- Seatbelt assembly. Autoliv ESA-DBP
- Seatbelt's short tube assembly. Autoliv ESA-DBP
- Seatbelt's solder paste manufacturing. Autoliv ESA-DBP
- Seatbelt's spindle assembly. Autoliv ESA-DBP
- Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP
- Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP
- Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP
- Seatbelt's tube manufacturing. Autoliv ESA-DBP
- Seatbelt's web sensor manufacturing. Autoliv ESA-DBP
- Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with processing the materials from the suppliers and ends with completing the tongue. Data given by tongue manufacturer show only water emissions but they all are treated.
Time Boundary	The data were acquired in January 2010, but the electricity data and sale data come from the year 2008.
Geographical Boundary	The manufacturer and its suppliers are located in Germany.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of electricity, oil, gas and emissions. Those values were given for the annual production. Allocation was based on the value on annual production and value of studied product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Cr	7.45E-02			g	Technosphere	Germany
	Input	Refined resource	Cu	3.16E-01			g	Technosphere	Germany

	Input	Refined resource	Electricity	2.35E-01			MJ	Technosphere	Germany
Notes: Is transported 27km from the plant and physically treated	Input	Refined resource	Ni	3.16E-01			g	Technosphere	Germany
	Input	Refined resource	Oil	9.1E-03			MJ	Technosphere	Germany
	Input	Refined resource	Polypropylene	8			g	Technosphere	Germany
	Input	Refined resource	Steel	43.88			g	Technosphere	Germany
	Input	Resource	Gas	5.88E-03			MJ	Technosphere	Germany
Notes: It is released in a slurry and transported 27km from the plant and physically treated	Output	Emission	Cr	3.09E-04			g	Water	Germany
Notes: It is released in a slurry and transported 27km from the plant and physically treated	Output	Emission	Cu	3.09E-04			g	Water	Germany
Notes: It is released in a slurry and transported 27km from the plant and combusted	Output	Emission	Cyanide	1.42E-05			g	Water	Germany
Notes: It is released in a slurry and transported 27km from the plant and physically treated	Output	Emission	Ni	3.09E-04			g	Water	Germany
Notes: The ready product is transported to the assembly plant which is located in Hungary. The product weighs 52.49 grams.	Output	Product	Tongue	1			pce	Technosphere	Germany
Notes: Indoor water treatment	Output	Residue	Galvanic waste water	4.36E-01			g	Technosphere	Germany
Notes: Separated and refined	Output	Residue	Oil and water emulsion	4.6E-04			g	Technosphere	Germany
Notes: Is remelted	Output	Residue	Scrap	1.07			g	Technosphere	Germany

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed tongue is a part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicabilty for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek Importer of data: Filippa Fuhrman (ESA) assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the tongue should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's tube manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's tube manufacturing. Autoliv ESA-DBP
Functional Unit	1 tube
Functional Unit Explanation	1 tube weighs 97.5 grams and it is a part of seatbelt which weighs 1129.865 grams
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	The tube is a part of the seatbelt. It is placed in the pretensioner retractor. It is used for assembly the 'short tube' which is ended with gas generator. In the tube massbodies (balls) are located which are a part of the mechanism for tighting the seatbelt after a crash. It is ended with gas generator and when a crash occurs, gas pushes the balls which activate the mechanism of tightening the seatbelt. The tube is manufactured in Linz, Austria and then transported to Autoliv Hungary. The main input for this process is a raw tube which is made of steel and weighs 97.5 grams. The steps connected with tube manufacturing are as followed: 1. Delivery and inspection of the materials (raw tube) 2. Raw tube purification with HCl 3. Drawing process 4. Heat treatment I (annealing at 900 degrees) 5. Drawing process with flexible inner tool 6. Heat treatment II 7. Finishing and oiling 8. Bending 9. Stamping 10. Expanding 11. Verifying 12. Packing and inspection This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP - Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's web sensor manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with inspection of the raw tube, followed by the manufacturing process and ends with final control and shipment . Data given by tube manufacturer show air and water emissions.
Time Boundary	The data were acquired in January 2009, but the electricity data, emissions and weight data come from the year 2008.
Geographical Boundary	The plant is located in Linz, Austria.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocations were done based on weight of the total production and production of particular product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase /DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: The raw tube is manufactured in Düsseldorf, Germany	Input	Input Product	Raw tube	9.70E+01			g	Technosphere	
	Input	Natural resource	Water	1.43E-02			l	Technosphere	Austria
	Input	Refined resource	Electricity	1.89E-02			MJ	Technosphere	Austria
Notes: Produced in Wien, Austria	Input	Refined resource	HCl	2.53E-03			g	Technosphere	Austria
	Input	Resource	Gas	1.05E-02			MJ	Technosphere	Austria
	Output	Emission	CO	1.26E-03			g	Air	
	Output	Emission	Dust	6.22E-04			g	Air	
	Output	Emission	HCl	5.03E-03			g	Air	
	Output	Emission	NaOH	3.14E-04			g	Technosphere	
	Output	Emission	NH4-N	4.56E-04			g	Water	
	Output	Emission	Nitrite	3.82E-04			g	Water	
	Output	Emission	NOx	8.37E-03			g	Air	
Notes: The finished product is transported to Autoliv in Hungary and then assembled into 'tube, short tube'. The product weighs 97.5 grams.	Output	Product	Tube	1			pce	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practicioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment
Detailed Purpose	The discussed tube is the part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential.
Commissioner	Autoliv Development AB - .

Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the tube should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's web sensor manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's web sensor manufacturing. Autoliv ESA-DBP
Functional Unit	1 web sensor
Functional Unit Explanation	1 web sensor weighs 18 grams
Process Type	Gate to gate
Site	Autoliv ALH. Sopronkövesd, Hungary.
Sector	Manufacturing
Owner	Autoliv ALH. Sopronkövesd, Hungary.
Technical system description	The web sensor is a part of the seatbelt and it is located in the pretensioner retractor. It is made of 4 main components: ratchet wheel (plastics), lever (plastics), spring (stainless steel) and mass (coated alloy). It weighs 18 grams. The web sensor is produced in Autoliv Hungary and then is assembled into the pretensioner retractor and in the end to the seatbelt. The assembly of the web sensor is done partially manually and with the usage of special equipment. This process is included in the system described in: Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf Other processes in the CPM Database also included in the above publication: - Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP - Seatbelt's bobbin manufacturing. Autoliv ESA-DBP - Seatbelt's frame production. Autoliv ESA-DBP - Seatbelt's gas generator assembly. Autoliv ESA-DBP - Seatbelt's polyamide granules production. Autoliv ESA-DBP - Seatbelt's header manufacturing. Autoliv ESA-DBP - Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP - Seatbelt's label bam manufacturing. Autoliv ESA-DBP - Seatbelt's pillar loop production. Autoliv ESA-DBP - Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP

	- Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP - Seatbelt assembly. Autoliv ESA-DBP - Seatbelt's short tube assembly. Autoliv ESA-DBP - Seatbelt's solder paste manufacturing. Autoliv ESA-DBP - Seatbelt's spindle assembly. Autoliv ESA-DBP - Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP - Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP - Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP - Seatbelt's tongue production. Autoliv ESA-DBP - Seatbelt's tube manufacturing. Autoliv ESA-DBP - Seatbelt's webbing manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It relates to the manufacturing of web sensor. Data given by web sensor manufacturer show air and water emissions.
Time Boundary	The data were acquired in November 2009, but the they come from the year 2008.
Geographical Boundary	The manufacturer is located in Hungary.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	The allocation procedure was applicable in case of energy, water and emissions. Those values were given for the annual production. The allocation was done based on the information that half of the resources is used for activities connected with seatbelt production and then allocated according to the operation time.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: The product weighs 0.3 gram	Input	Input Product	Lever, web sense	1			pce	Technosphere	
Notes: The product weighs 12 grams	Input	Input Product	Mass, web sense	1			pce	Technosphere	
Notes: The product weighs 5.7 grams	Input	Input Product	Ratchet wheel	1			pce	Technosphere	
Notes: The product weighs 0.035 gram	Input	Input Product	Spring, web sense	1			pce	Technosphere	
	Input	Natural resource	Water	5.75E-04			MJ	Technosphere	
	Input	Refined resource	Electricity	7.61E-04			MJ	Technosphere	Hungary
	Input	Refined resource	Gas	4.21E-04			MJ	Technosphere	
	Output	Emission	NOx	8.79E-06			g	Air	
	Output	Emission	Sludge	5.75E-01			g	Water	
	Output	Emission	SOx	6.57E-07			g	Air	
	Output	Emission	Susp solids	9.51E-08			g	Air	
Notes: The product weighs 18 grams	Output	Product	Web sensor	1			pce	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the followed products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.

Detailed Purpose	The discussed web sensor is a part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the web sensor should be recovered in a high rate. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Seatbelt's webbing manufacturing. Autoliv ESA-DBP

Administrative	
Finished	Y
Date Completed	2010-07-08
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Seatbelt's webbing manufacturing. Autoliv ESA-DBP
Functional Unit	1 meter of webbing
Functional Unit Explanation	1 meter of webbing weighs 57.8 grams. For the studied seatbelt 3.77 meters is used. The seatbelt weighs 1129.865 grams.
Process Type	Gate to gate
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Webbing is a most visible part of the seatbelt. It is basically the 'belt' that everybody can see. It is a part which has a direct contact with the occupant on the seat and is connected with the buckle with the usage of the tongue and the tension of it is adjusted by the pretensioner retractor. It is made of yarn and for 1 seatbelt 3.77 meters of webbing is needed. The webbing is produced in the plant which is located in Ieper, Belgium. The manufacturing process consists of following steps: 1. Weaving 2. Dyeing 3. Inspection 4. Cutting the webbing for seatbelts

This process is included in the system described in:
Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden.
Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf

Other processes in the CPM Database also included in the above publication:
- Seatbelt's car sense ball manufacturing. Autoliv ESA-DBP
- Seatbelt's bobbin manufacturing. Autoliv ESA-DBP
- Seatbelt's frame production. Autoliv ESA-DBP
- Seatbelt's gas generator assembly. Autoliv ESA-DBP
- Seatbelt's polyamide granules production. Autoliv ESA-DBP
- Seatbelt's header manufacturing. Autoliv ESA-DBP
- Seatbelt's initiator serviceable assembly. Autoliv ESA-DBP
- Seatbelt's label bam manufacturing. Autoliv ESA-DBP
- Seatbelt's pillar loop production. Autoliv ESA-DBP
- Seatbelt's pretensioner retractor assembly. Autoliv ESA-DBP
- Seatbelt's rivet nut manufacturing. Autoliv ESA-DBP
- Seatbelt assembly. Autoliv ESA-DBP
- Seatbelt's short tube assembly. Autoliv ESA-DBP
- Seatbelt's solder paste manufacturing. Autoliv ESA-DBP
- Seatbelt's spindle assembly. Autoliv ESA-DBP
- Seatbelt's spring antiretour manufacturing. Autoliv ESA-DBP
- Seatbelt's spring, wire manufacturing. Autoliv ESA-DBP
- Seatbelt's synchronization ball manufacturing. Autoliv ESA-DBP
- Seatbelt's tongue production. Autoliv ESA-DBP
- Seatbelt's tube manufacturing. Autoliv ESA-DBP
- Seatbelt's web sensor manufacturing. Autoliv ESA-DBP

System Boundaries

Nature Boundary	The performed study is gate-to-gate. It starts with weaving the material and ends with cutting the webbing. Data given by webbing manufacturer show only water emissions.
Time Boundary	The data were acquired in October 2009, but they come from the year 2008.
Geographical Boundary	The manufacturing plant is located in Ieper, Belgium.
Other Boundaries	Excerpt from the report, see 'Literature reference': ''Maintenance of production capital as well as personnel related environmental impacts were excluded from the study. Transportation within the production plant was not included.''
Allocations	Electricity and gas were given in annual values, but they were divided by the number of meters produced per year. The data for content and water were given per 1000 meters of webbing.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2009
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered from manufacturer using data collection sheet.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Water	9.10E-01			l	Technosphere	
	Input	Refined resource	Auxilliaries	2.80E-01			g	Technosphere	
	Input	Refined resource	Dyestuff	8.38E-02			g	Technosphere	
	Input	Refined resource	Electricity	7.00E-01			MJ	Technosphere	Belgium
	Input	Refined resource	Yarn	1.04E+00			m	Technosphere	
	Input	Resource	Gas	2.38E+00			MJ	Technosphere	
	Output	Emission	Waste water	2.41E-01			l	Water	
Notes: 1 meter of webbing weighs 57.8 grams	Output	Product	Webbing	1.00E+00			m	Technosphere	

About Inventory

Publication	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--4.pdf
Intended User	LCA practitioner
General Purpose	Autoliv has decided to perform 4 LCA projects for the following products: airbag, seatbelt, night vision camera (NVC) and electronic control unit (ECU). The main purpose was to learn more about the products and their environmental performances and eventually decrease their impact on the environment.
Detailed Purpose	The discussed webbing is a part of the seatbelt which was the object of the study. The main goals of the study are: 1. Determining the environmental load from seatbelt life cycle focused on 5 impact assessment categories: global warming, acidification, eutrophication, ecotoxicity, human toxicity 2. Comparing the Autoliv performance and performances of its suppliers based on seatbelt production 3. Determining which component of seatbelt influences the environment the most 4. Comparison of seatbelt and airbag (also produced by Autoliv) performance 5. Determining whether the transportation has significant contribution on global warming potential
Commissioner	Autoliv Development AB - .
Practitioner	Katarzyna Iwanek & Nima Samiee - .
Reviewer	Birgit Brunklaus & Henrikke Baumann -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Year 2010. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: the Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environemental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study it was assumed that the scenario for the end of life is that the seatbelt is shredded together with the car. According to Stena Recycling AB in Sweden, 96-99% of metals like cooper or aluminium and the same amount of iron are recycled in reality. Moreover, 99% of plastics is energy recovered fraction. Based on the above numbers, the webbing should be recovered as an energy in a high rate of 99%. The studied product is a part of the seatbelt which was the object of the LCA study for Autoliv. More processes from the same study were also documented in this database. In parallel to the seatbelt, 3 other LCA studies for Autoliv were carried out (for airbag, night vision camera and electronic control unit). Some of the processes can be found also in the CPM database.

SPINE LCI dataset: Si wafer production and Si wafer processing for integrated circuits

Administrative	
Finished	Y
Date Completed	2000-03-03
Copyright	Ericsson
Availability	Official

Technical System	
Name	Si wafer production and Si wafer processing for integrated circuits
Functional Unit	1 mm2 silicon wafer surface.
Functional Unit Explanation	The motivation for choosing this functional unit is: · suitable unit to work with in an LCA of a private branch exchange (a complicated telecom product) · important component of the MD110 product system and many other electronic products. One chip from the manufactured silicon wafer is a sub-part of the SOP14 capsule. No design specifications exist for silicon wafers. A product specification for the SOP14 capsule can be found in the activity Integrated circuit capsule assembly.

Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the production of a silicon wafer used for integrated circuits, and describes the chain from quartz to silicon wafer. The activity is based on information acquired from three manufacturers. The description of the process is supplied by manufacturer one, but is assumed to be general for this type of manufacture. The following process steps are included; -- Silicon processing and wafer production-- First the quartz sand has has to be transformed to metallic grade silicon (MG Si) and then the metallic grade silicon is transfered to electronic grade silicon (EG Si). The last step is EG Si transformation to Si wafer. Typical steps Si wafer production: Reduction of SiO2 ---> Si ----> Si wafer -- Silicon wafer processing -- Typical steps Si wafer processing: 1. Applying photoresist 2. Litography 3. Etching 4. Deposition of metal or other layers 5. Stripping of photresistlayers In the so called mask steps the above steps are repeated.

System Boundaries

Nature Boundary	The emissions to air and water have nature as recipient. Each parameter mentioned by the component manufacturers has been studied. No parameter has deliberately been disregarded when environmental impacts have been studied. Included component manufacturers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used.
Time Boundary	1997 The answer from the manufacturer arrived in 1998 and they measured in 1997. The process technology used is most certainly the best available as the factories are located in the Netherlands, Sweden and Malaysia and the companies are well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturers included in the average are located in the Netherlands, Sweden and Malaysia.
Other Boundaries	Delimitations to the system is the making of the Silicon wafer.The production of the subparts (e.g. ceramic, caps, leads and targets) of the resistor is not included in this model The transportation of them to the factory is not included.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The data that are presented are calculated as a average based on information from three component manufacturers. The information from the manufacturers was acquired using a LCI data questionnaire. The average for each presented flow is calculated as follows: - First the amount of each flow per functional unit is calculated for each component manufacturer - Then the calculated amount for each component manufacturer is summed for each unique flow and divided by the number of included component manufacturers In the information supplied by the manufacturer, they had indicated whether the data for each flow were measured, estimated or calculated. Below is a detailed account of the calculation procedure. Definition of variables: CMn: Component manufacturer number n. Myn: Materials, emission, waste, energy (y) given in component answer n. ACyn: Amount of material y in component, expressed in mg (or similar) by component manufacturer n Wn: Weight of one piece of component, expressed in mg (or similar) by component manufacturer n. Nyn: The flow y expressed per functional unit from manufacturer n. Step 1. For CM1 sum AC1+..+.ACn Step 2: The sum AC11+..+.ACyn = W1 Step 3: Divide all flows between M11...M1n by W1 --> N11...N1n Step 4: Repeat Step 1 to 3 for all component manufacturers and for each flow. Step 5: Sum N1n+..Nyn and divide by the number of terms for each unique flow.(material input, emission etc.) An average calculation like above of up to three answers was made.

Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Data type: Derived, unspecified Method: This flow represents different acids such as HF, HNO3 and H2SO4. As different producers have diffrent degree of resolution we have decided to fold them under a common name, Acids. CM1: 42,66 mg/mm2 CM2: 228,07 mg/mm2 CM3: 6,85 mg/mm2 (CM1+CM2+CM3)/3 = 92,52 mg/mm2 This is an average value based on three sources.	Input	Refined resource	Acids	0.09252			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 3,3 mg/mm2 This is not an average value and the figure is based only on one answer.	Input	Refined resource	Al	0.0033			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 3,74 mg/mm2 CM2: 132 mg/mm2 (CM1+CM2)/2 = 67,87 mg/mm2 This is an average value based on two sources.	Input	Refined resource	Ar	0.06787			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 187 mg/mm2 This is not an average value and the figure is based only on one answer.	Input	Refined resource	CaO	0.187			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 48,6 mg/mm2 CM3: 1,26 mg/mm2 (CM2+CM3)/2 = 24,93 mg/mm2 LHV for char coal: 29,3 MJ/kg 24,93 mg = 24,93e-6 kg 24,93 * 29,3 = 7,3e-4 MJ/mm2 This is an average value based on two sources. Literature: Brohammer, Göran, ''Produktekologi'', ISBN 91-7548-544-3, (116)	Input	Refined resource	Coal	0.00073			MJ	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: Comp. man 1: 11,64 Wh / mm2 chip surface Comp. man 2: 29,3 Wh /mm2 chip surface Comp. man 3: (65/2) Wh for the chip production --> 32,5 Wh for the chip production. The whole amount is not used to produce 1 mm2 though. We assume that 0,6e-3 g silicon chip corresponds to 1 mm2 silicon chip according to an answer from CM1. CM 3 indicate their chip weighs 1,5 mg ---> 32,5/(1,5/0,6) = 13 Wh/mm2 All assuming to 100 % yield, which is not realistic. (11,64+29,3+13)/3 = 17,98 Wh/g capsule This is an average value based on three sources.	Input	Refined resource	Electricity	17.98			Wh	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 12,1 mg/mm2 This is not an average value and the figure is based only on one answer. Notes: ferric chloride has CAS number 7705-08-0	Input	Refined resource	ferric chloride	0.0121			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: This flow represents different gases such as BF3, PH3 and SF6. As different producers have diffrent degree of resolution we have decided to fold them under a common name, Gases CM1: 6,29 mg/mm2 CM2: 9,89 mg/mm2 (CM1+CM2)/2 = 8,09 mg/mm2 This is an average value based on two sources.	Input	Refined resource	Gases	0.00809			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 16,4 mg/mm2 This is not an average value and the figure is based only on one answer.	Input	Refined resource	Graphite	0.0164			g	Technosphere	

Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 3 mg/mm2 CM2: 21 mg/mm2 (CM1+CM2)/2 = 12 mg/mm2 This is an average value based on two sources.	Input	Refined resource	H2	0.012			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 88,6 mg/mm2 CM3: 32,2 mg/mm2 (CM1+CM3)/2 = 60,4 mg/mm2 This is an average value based on two sources.	Input	Refined resource	Hydrochloric acid	0.0604			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 2,4 mg/mm2 This is not an average value and the figure is based only on one answer.	Input	Refined resource	Hydrogen Chloride	0.0024			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: This flow represents different inorganics and salts such as H2O2 and KOH. As different producers have diffrent degree of resolution we have decided to fold them under a common name, Gases CM1: 40,69 mg/mm2 CM2: 78,6 mg/mm2 CM3: 1,15 mg/mm2 (CM1+CM2+CM3)/3 = 40,15 mg/mm2 This is an average value based on three sources.	Input	Refined resource	Inorganics + salts	0.04015			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 2,44 mg/mm2 CM2: 1 mg/mm2 (CM1+CM2)/2 = 1,72 mg/mm2 This is an average value based on two sources.	Input	Refined resource	Kraftliner	0.00172			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1 states a consuption of 0,51 dm3 per mm2 chip. Approximately: We assume furnace gas consists of propane. According to HTTP://chemfinder.camsoft.com/cgi-win/cfserver.exe/ thr vapour density is 1,55 g/dm3. Hnence 0,51 dm3 weighs 0,7905 g. Corresponds to 0,7905/44,09 moles (page 620 Felder/Rosseau). Heat of combustion for C3H8 (l) gives 0,7905/44,09 * 2204 kJ/mol = 39,51 kJ Without losses. This is not an average value and the figure is based only on one answer. Literature: ''Elementary Principles of Chemical Processes'' 2nd Ed. Felder, Richard M. Rousseau, Ronald W. John Wiley & Sons (1986), 620.	Input	Refined resource	Liquefied petroleum gas	0.03951			MJ	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 10,1 g/mm2	Input	Refined resource	N2	10.1			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 40 kJ/mm2 This is not an average value and the figure is based only on one answer.	Input	Refined resource	Oil	0.04			MJ	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: This flow represents different organics such as acetone and ethanol. As different producers have diffrent degree of resolution we have decided to fold them under a common name, Organics CM1: 28,5 mg/mm2 CM2: 45,1 mg/mm2 CM3: 36,75 mg/mm2 (CM1+CM2+CM3)/3 = 36,78 mg/mm2 This is an average value based on three sources.	Input	Refined resource	Organics	0.03678			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,46 mg/mm2 CM2: 95 mg/mm2 (CM1+CM2)/2 =47,73 mg/mm2 This is an average value based on two sources.	Input	Refined resource	Oxygen	0.04773			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 15,53 mg/mm2 CM2: 2 mg/mm2 (CM1+CM2)/2 = 8,765 mg/mm2 This is an average value based on two sources.	Input	Refined resource	Polyethylene	0.008765			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 2,26 mg/mm2	Input	Refined resource	Polypropylene	0.00226			g	Technosphere	

Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,51 mg/mm2	Input	Refined resource	Salts	0.00051			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 66,8 mg/mm2 CM2: 3,2 mg/mm2 (CM1+CM2)/2 = 35 mg/mm2 This is an average value based on two sources.	Input	Refined resource	SiO2	0.035			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 96,386 mg/mm2 CM3: 40 mg/mm2 (CM1+CM3)/2 = 68,193 mg/mm2 This is an average value based on two sources.	Input	Refined resource	Water	68.193			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 34,3 mg/mm2	Input	Refined resource	Wood	0.0343			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 6,97 mg/mm2	Input	Refined resource	Zn	0.00697			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 13,7 mg/mm2 CM3: 1,5 mg/mm2 (CM2+CM3)/2 = 7,6 mg/mm2 This is an average value based on two sources.	Output	Emission	Acetone	0.0076			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 1,51 mg/mm2	Output	Emission	Acids	0.00151			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 1,8 mg/mm2	Output	Emission	Acids	0.0018			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 3,74 mg/mm2 CM2: 132 mg/mm2 (CM1+CM2)/2 = 67,87 mg/mm2 This is an average value based on two sources.	Output	Emission	Ar	0.06787			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 14,3 mg/mm2 CM2: 2 mg/mm2 (CM1+CM2)/2 = 8,15 mg/mm2 This is an average value based on two sources.	Output	Emission	CO2	0.00815			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 0,5 mg/mm2	Output	Emission	Ethylene glycol	0.0005			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 1,14 mg/mm2	Output	Emission	Gases	0.00114			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 0,05 mg/mm2	Output	Emission	Glycol ethers	0.00005			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 3,26 mg/mm2	Output	Emission	H2	0.00326			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 0,5 mg/mm2	Output	Emission	H3PO4	0.0005			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 0,05 mg/mm2	Output	Emission	HF	0.00005			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 0,05 mg/mm2	Output	Emission	HNO3	0.00002			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 6,29 mg/mm2	Output	Emission	Hydrochloric acid	0.00629			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 40,54 mg/mm2	Output	Emission	Inorganic compounds (not metals)	0.04054			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 0,91 mg/mm2	Output	Emission	Metal chlorides	0.00091			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 0,15 mg/mm2	Output	Emission	Nitrates	0.00015			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 0,5 mg/mm2	Output	Emission	N-methyl-2-pyrolidone	0.0005			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 9,94 mg/mm2	Output	Emission	Organics	0.00994			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,4 mg/mm2	Output	Emission	Salts	0.0004			g	Water	

Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,17 mg/mm2	Output	Emission	SiO2	0.00017			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 96,386 mg/mm2 CM3: 35 mg/mm2 (CM1+CM3)/2 = 65,693 mg/mm2 This is an average value based on two sources.	Output	Emission	Water	65.693			g	Water	
Date concieved: 1999 Data type: Derived, unspecified Method: Silicon wafer = Life Cycle Inventory model for production of one mm2 (square millimeter) of silicon wafer for making of integrated circuit chips used in integrated circuit capsules (applicable to telecommunication equipment).	Output	Product	Silicon wafer	1			mm2	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 7,6 mg/mm2 CM3: 15 mg/mm2 (CM1+CM2)/2 =11,3 mg/mm2 This is an average value based on two sources.	Output	Residue	Acetone	0.0113			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,19 mg/mm2	Output	Residue	Al	0.00019			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 0,1 mg/mm2	Output	Residue	CFC	0.0001			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 7 mg/mm2	Output	Residue	Ethylene glycol	0.007			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 7,45 mg/mm2	Output	Residue	Glycol ethers	0.00745			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,014 mg/mm2	Output	Residue	Graphite	0.000014			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 1,77 mg/mm2	Output	Residue	H2SO4	0.00177			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 6 mg/mm2	Output	Residue	H3PO4	0.006			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 0,15 mg/mm2 This waste output of HF orgins from the raw material input of Acids.	Output	Residue	HF	0.00015			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 0,1 mg/mm2	Output	Residue	HNO3	0.0001			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 19,8 mg/mm2 This is stated as petroleum hydrocarbons for waste, probably oil rests.	Output	Residue	Hydrocarbons	0.0198			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 14,3 g/mm2	Output	Residue	Industrial sewage	14.3			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 2,44 mg/mm2	Output	Residue	Kraftliner	0.00244			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 307 mg/mm2	Output	Residue	Lime sludge	0.307			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 2,32 mg/mm2	Output	Residue	NaOH	0.00232			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 1 mg/mm2 0.15 mg/mm2 of the Nitrates are emitted to water and 1 mg/mm2 end up as waste.	Output	Residue	Nitrates	0.001			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 4 mg/mm2	Output	Residue	N-methyl-2-pyrolidone	0.004			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 14,3 g/mm2	Output	Residue	Non-chlorinated solvents	14.3			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 19,05 mg/mm2	Output	Residue	Organics	0.01905			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,014 mg/mm2	Output	Residue	Plastic waste	0.000014			g	Technosphere	

Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 1,23 mg/mm2	Output	Residue	Polyethylene	0.00123			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 2,26 mg/mm2	Output	Residue	Polypropylene	0.00226			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,26 mg/mm2	Output	Residue	Salts	0.00026			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 65 mg/mm2	Output	Residue	Si	0.065			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM2: 0,07 mg/mm2 The chemical composition of the suspended solids was not given by manufacturer two.	Output	Residue	Suspended solids	0.00007			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM3: 5 g/mm2	Output	Residue	Water	5			g	Technosphere	

About Inventory

Publication	Not available. -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a silicon wafer process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the silicon wafer (for IC) production in our telecom products. The usage for this set of data are life cycle assessments where integrated circuit chips of silicon are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly

	5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to silicon wafers used for integrated circuits (i.e. IC´s) in electronic equipment if you the total chip area of the chips in the IC´s. The model shall be regarded as one of two connected models describing three main steps in the manufacturing of a integrated circuit.
About Data	The data is based on information from one Dutch, one Swedish and one Malaysian manufacturer. For component manufacturer one and two (CM1 and CM2) the information was gathered using the manufactures own brochures and investigations respectively. The information from CM3 was gathered using a life cycle inventory questionnaire. All flows are not average values and where there were only one manufacturer stating a certain flow, this one was chosen in the model. Of the flows about little less than 74 % are not average values. The flows for Energy inputs of Coal and Electricity, Raw material inputs of Acids, Ar(g), Gases, H2, HCl, Inorganics + salts, Kraftliner, LDPE, Organics, Oxygen, SiO2 and Water, Emissions to air of Acetone, Ar(g) and CO2, Emission to water of water, Waste output of Acetone are average values. In specific QMetaData for each flow, we have indicated specifically for each flow how many manufacturers have been included. The outline of the LCI data questionnaire that were used in the inventory follows below. No limitations or specifications were set for which substances they had to account -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes.´ Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gatherd it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information.

	Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Si wafer production and Si wafer processing for transistors

Administrative	
Finished	Y
Date Completed	2000-03-07
Copyright	Ericsson
Availability	Official

Technical System	
Name	Si wafer production and Si wafer processing for transistors
Functional Unit	1 mm2 transistor wafer (Si) surface.
Functional Unit Explanation	The motivation for choosing this functional unit is: · Suitable unit to work with in an LCA of a private branch exchange (a complicated telecom product) · Important component of the MD110 product system and many other electronic products. One chip from the manufactured silicon wafer is a sub-part of the SOT23 capsule. No design specifications exist for silicon wafers. A product specification for the SOT23 capsule can be found in the activity Transistor assembly.
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the production of a silicon wafer used for transistors, and describes the chain from quartz to silicon wafer. The activity is based on information acquired from one manufacturer. The description of the process is supplied by manufacturer one, but is assumed to be general for this type of manufacture. The following process steps are included; -- Silicon processing and wafer production-- First the quartz sand has to be transformed to metallic grade silicon (MG Si) and then the metallic grade silicon is transferred to electronic grade silicon (EG Si). The last step is EG Si transformation to Si wafer. Typical steps in Si wafer production: Reduction of SiO2 ---> Si ----> Si wafer -- Silicon wafer processing -- Typical steps Si wafer processing: 1. Applying photoresist 2. Lithography 3. Etching 4. Deposition of metal or other layers 5. Stripping of photoresistlayers

	In the so called mask steps the above steps are repeated.

System Boundaries	
Nature Boundary	The emissions to air and water have nature as recipient. Each parameter mentioned by the component manufacturer has been studied. No parameter has deliberately been disregarded when environmental impacts have been studied. Included component manufacturers have not specified the same parameters. In the cases where only one manufacturer has stated a parameter this has been used.
Time Boundary	1997 The answer from the manufacturer arrived in 1998 and they measured in 1997. The process technology used is most certainly the best available as the factory the company are well established. The location of the factory is the Netherlands.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The location is the Netherlands. It is not specified if the silicon manufacturing and the silicon processing take place in the same factory.
Other Boundaries	Delimitations to the system are the Si wafer production and Si wafer processing steps in the making of the transistor. The production of the ancillary materials (e.g. salts, organics and gases) needed is not included in this model. The transportation of them to the factory is not included.
Allocations	The manufacturer has partly described how the allocation has been made. The following details were given by the manufacturer: Description of allocations of energy flows: - Auxiliary buildings/processes Product development, pilot assembly, quality testing and measurement, some technical facilities have been allocated to incoming wafer area. - Epitaxy have been allocated to processed wafer area. - Some technical facilities have been allocated to electricity use of wafer fab. - Wafer sawing and cleaning of vacuum devices have been allocated to equal division over waferfabs. - Canteen have been allocated to employees of wafer fab. We did not decide or have any suggestions on how the manufacturer should allocate in their factory. The energy flows have been allocated with help from the facility department.
Systems Expansions	None.

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, unspecified
Represents	See 'Function'
Method	We asked three manufacturers for a transistor with capsule size SOT23. This model only describe the Si wafer production and Si wafer processing, and not the assembly/encapsulation to the semiconductor (SOT23) device. The model shall be regarded as one of two connected models describing three main steps in the manufacturing of a transistor. We got one usable answer, here referred to as CM, and the data that are presented are based on information this component manufacturer. The information was requested using a LCI data questionnaire. However, the manufacturer instead sent a brochure containing the requested information. The data presented here are based on this brochure.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***

Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 1,37 + 53,8 = 55,17 mg/mm2 1.37 g (Silicon manufacturing) + 53.8 g (proccessing of silicon into silicon wafers, later transported to the assembly) Notes: Acids stated are HF, Hydrofluoric Acid, CAS-number, 7664-39-3 HNO3, Nitric acid, 7697-37-2 H2SO4, Sulfuric acid, 7664-93-9 H3PO4, phosphoric acid, 7664-38-2 C2H4O2, Acetic acid, 64-19-7 NH4F mix, Ammonium fluoride, 12125-01-8	Input	Refined resource	Acids	0.055			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0.19 mg/mm2 in Si processing Notes: Packaging material stated as Al-foil	Input	Refined resource	Al	0.0019			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 3,74 mg/mm2 Notes: Argon, CAS-number 7440-37-1 is used i Silicon manufacturing. SiO2 ---> Si	Input	Refined resource	Ar	0.0037			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 48.6 mg is used per mm2. Notes: Organics are used both in Si manufacturing and Si processing. Organics are only stated in the latter: Acetone Ethanol Isopropylealcohol Ethylethoxypropioate Butylacetate Ethylacetate Ethene Glycol Xylene Alkylbenzenes N-methylpyrrolidone 2-aminoethoxyethanol Photolaquer	Input	Refined resource	Coal	0.0049			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 1,54 Wh (Silicon manufacturing) + 10,2 Wh (proccessing of silicon into silicon wafers, later transported to the assembly) = 11,74 Wh/mm2	Input	Refined resource	Electricity	11.74			Wh	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 6,46 mg/mm2 Notes: Gases used in Si processing. Gases stated are BF3, Boron Trifluoride,CAS-number 7637-07-2 PH3, Phosphine, 7803-51-2 SiH4, Silicon Tetrahydride, 7803-62-5 SiH2, Silylene, 13825-90-6 Cl2, Chlorine, 7782-50-5 C2H4Cl2, 1,2-Dichloroethane, 107-06-2 NH3, Ammonia, 7664-41-7 SF6, Sulfur Hexafluoride, 2551-62-4 CF4, Carbon Tetrafluoride, 75-73-0 C2F6, hexafluoroethane, 76-16-4 CHF3, trifluoromethane, 75-46-7 BCl3, boron trichloride, 10294-34-5 CH4, Methane, 74-82-8	Input	Refined resource	Gases	0.0065			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 16,4 mg/mm2 Notes: Graphite, CAS-no. 7782-42-5 is used in SiO2 ---> Si	Input	Refined resource	Graphite	0.016			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 3 mg/mm2 Notes: Hydrogen, CAS-no.1333-74-0 is used in SiO2 ---> Si	Input	Refined resource	H2	0.003			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 88,6 mg/mm2 Notes: Hydrochloric acid, CAS-no.1333-74-0 is used in SiO2 ---> Si	Input	Refined resource	Hydrochloric acid	0.089			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 96,1 mg/mm2 Notes: Inorganics and salts are used in Si processing. Inorganics and salts stated are H2O2, hydrogen peroxide,CAS-number 7722-84-1 NaOH, Sodium hydroxide, 1310-73-2 KOH, Potassium hydroxide, 1310-58-3 and some unspecified Lacquer	Input	Refined resource	Inorganics + salts	0.096			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 4,6 mg/mm2 Notes: Packaging material stated as Cardboard	Input	Refined resource	Kraftliner	0.0046			g	Technosphere	

Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,04 mg metals/mm2 Notes: The metals are used in Si processing. The metals stated are Ag, Silver, CAS-number, 7440-22-4 Cu, copper, 7440-50-8 Al, Aluminum, 7429-90-5 Ni, Nickel, 7440-02-0	Input	Refined resource	Metals	0.00004			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,49 + 28,7 = 29,19 mg/mm2 Notes: Organics used in Si processing. Organics stated are Acetone Ethanol Isopropylealcohol Ethylethoxypropioate Butylacetate Ethylacetate Ethene Glycol Xylene Alkylbenzenes N-methylpyrrolidone 2-aminoethoxyethanol Photolaquer	Input	Refined resource	Organics	0.029			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,46 mg/mm2 Notes: This oxygen is used in Si manufacturing.	Input	Refined resource	Oxygen	0.00046			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 14.3 + 2.29 = 16.59 mg/mm2 14.3 g (Silicon manufacturing) + 2.29 g (proccessing of silicon into silicon wafers, later transported to the assembly) Notes: Packaging material stated as PE	Input	Refined resource	Polyethylene	0.017			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 4,26 mg/mm2 Notes: Packaging material stated as Cardboard	Input	Refined resource	Polypropylene	0.0043			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: Stated as Furnace gas which I have approximated with propane. CM1: 0,52 dm3/mm2 Vapor density: 1,55 kg/m3 = 1,55g /dm3 (HTTP://chemfinder.camsoft.com /result.asp) 0,52 dm3 propane weighs approximately 0,806 g 50,54 MJ /kg is the Higher Heating Value for propane according to Brohammer, Produktekologi (ISBN 91-7548-544-3) 0,806e-3*50,54 = 0,0407 MJ/mm2	Input	Refined resource	Propane	0.041			MJ	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0,51 mg/mm2 Notes: These salts are used in Si manufacturing. Which salts are not specified.	Input	Refined resource	Salts	0.00051			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 66,8 mg/mm2 Notes: The flow is started as Quartz pieces by manufacturer. SiO2 ---> Si is the main reaction in the Si manufacturing.	Input	Refined resource	SiO2	0.067			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 3,286 + 227 = 230,286 g/mm2 3.286 g (Silicon manufacturing) + 227 g (processing of silicon into silicon wafers, later transported to the assembly) Notes: This water is used both in the silicon manufacturing and in the processing of the silicon.	Input	Refined resource	Water	230.29			g	Technosphere	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 34,3 g/mm2 Notes: This wood is used in Si manufacturing. Which wood is not specified.	Input	Refined resource	Wood	0.034			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 0.00151 + 0.0057 = 0.00721 g/mm2 0.00151 g (Silicon manufacturing) + 0.0057 g (processing of silicon into silicon wafers, later transported to the assembly)	Output	Emission	Acids	0.0072			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 53.11 mg/mm2 CM: 1.51 + 51.6 = 53.11 g/mm2 1.51 mg (Silicon manufacturing) + 51.6 mg (processing of silicon into silicon wafers,	Output	Emission	Acids	0.053			g	Water	

later transported to the assembly)									
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 3,74 mg/mm2	Output	Emission	Ar	0.0037			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 14,3 mg/mm2	Output	Emission	CO2	0.014			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM: 1,14 + 0,29 = 1,43 g/mm2 1.41 mg (Silicon manufacturing) + 0.29 mg (processing of silicon into silicon wafers, later transported to the assembly) Notes: The gases used in Si manufacturing are stated as gaser, other.	Output	Emission	Gases	0.0014			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 3,26 mg/mm2	Output	Emission	H2	0.0033			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 6,29 mg/mm2	Output	Emission	Hydrochloric acid	0.0063			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 1,54 mg/mm2	Output	Emission	Inorganic compounds (not metals)	0.0015			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 91,1 mg/mm2	Output	Emission	Inorganics + salts	0.091			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0,91 mg/mm2	Output	Emission	Metal chlorides	0.00091			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0.039 mg/mm2	Output	Emission	Metals	0.000039			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 15,8 mg/mm2 Notes: The organics are emitted to air during the Si processing.	Output	Emission	Organics	0.016			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0,4 mg/mm2	Output	Emission	Salts	0.0004			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0,17 mg/mm2	Output	Emission	SiO2	0.00017			g	Air	
Date concieved: 1998 Data type: Derived, unspecified Method: CM1: 3,286 + 227 = 230,286 g/mm2 3.286 g (Silicon manufacturing) + 227 g (processing of silicon into silicon wafers, later transported to the assembly)	Output	Emission	Water	230.29			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: Silicon wafer = Life Cycle Inventory model for production of one mm2 (square millimeter) of silicon wafer for making of transistor chips used in capsule type SOT23 (applicable to telecommunication equipment).	Output	Product	Silicon wafer	1			mm2	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0,34 mg/mm2 Al-foil waste	Output	Residue	Al	0.00034			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0,014 mg/mm2	Output	Residue	Graphite	0.000014			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 4,6 mg/mm2	Output	Residue	Kraftliner	0.0046			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0.49 + 12.9 = 13,39 mg/mm2	Output	Residue	Organics	0.013			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0,014 mg/mm2	Output	Residue	Plastic waste	0.000014			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 2,29 mg/mm2	Output	Residue	Polyethylene	0.0023			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 4,26 mg/mm2	Output	Residue	Polypropylene	0.0043			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0,26 mg/mm2	Output	Residue	Salts	0.00026			g	Technosphere	

Date concieved: 1997 Data type: Derived, unspecified Method: CM1: 65 mg/mm2 Notes: 100 % of the Si is recycled.	Output	Residue	Si	0.065			g	Technosphere	

About Inventory

Publication	Not available -- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The intended use for this LCI
General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a transistor chip process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the silicon manufacturing and silicon processing of transistor chips and resembling components in our telecom products. The usage for this set of data are life cycle assessments where transistors are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. This particular model is used in connection with a transistor assembly model describing the final assembly of transistors. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly

	13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden
Applicability	This set of data can be applied to silicon wafers used as chip in transistors in electronic equipment if you know the surface area of the silicon chips in the transistors. The model shall be regarded as one of two connected models describing three main steps in the manufacturing of a transistor.
About Data	The data is based on information from one Dutch manufacturer. The information was requested using a life cycle inventory questionnaire. The manufacturer chose to instead give us an owned made brochure with LCI data for their production. The data in the brochure answered our questions. Here is a quotation from the brochure: ''The data for inputs and outputs are real measured data, whereas the outputs of emissions to air and water and of waste are estimates, based on expert views.'' The outline of the LCI data questionnaire that was used in the inventory follows below. No limitations or specifications were set for which substances they had to account. -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes. Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gathered it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Silviculture of softwood AGGR

Flow Chart
This data set transparently reported, including a flowchart where each process is individually described

Administrative	
Finished	Y
Date Completed	1999
Copyright	
Availability	

Technical System	
Name	Silviculture of softwood AGGR
Functional Unit	1 m3 softwood at roadside
Functional Unit Explanation	
Process Type	Cradle to gate
Site	Sweden
Sector	Forestry
Owner	Sweden
Technical system description	The system describes the cultivation cycle for softwood delivered at road side in Sweden. The following subsystems are included: tree plant nursing, soil preparation, planting softwood plants, clearing of young forest, fertilising in silviculture, thinning of forest area, final felling and forwarding of harvested wood. See the flowchart to see how they are linked. See also the documentation of each of these included subsystems for a further description.

Flowchart
Click on flowchart to open each data set description

System Boundaries	
Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData	
Date Conceived	
Data Type	
Represents	See 'Function'
Method	We asked three manufacturers for a transistor with capsule size SOT23. This model only describe the Si wafer production and Si wafer processing, and not the assembly/encapsulation to the semiconductor (SOT23) device. The model shall be regarded as one of two connected models describing three main steps in the manufacturing of a transistor. We got one usable answer, here referred to as CM, and the data that are presented are based on information this component manufacturer. The information was requested using a LCI data questionnaire. However, the manufacturer instead sent a brochure containing the requested information. The data presented here are based on this brochure.
Literature Reference	Iwanek K., Samiee N. (2010). Life Cycle Assessment of Autoliv's front seatbelt. Master thesis report. ESA report 2010:4, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--4.pdf
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography

	Input	Refined resource	Diesel	153			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity	0.092			kWh	Technosphere	Sweden
	Input	Refined resource	Forest land	0.0025			ha	Technosphere	Sweden
	Input	Refined resource	Gasoline	0.98			MJ	Technosphere	Sweden
	Input	Refined resource	HDPE	0.0075			kg	Technosphere	Sweden
	Input	Refined resource	Kerosene	1.08			MJ	Technosphere	Sweden
	Input	Refined resource	Nitrogen fertiliser	0.38			kg	Technosphere	Sweden
	Input	Refined resource	Peat	0.09			kg	Technosphere	Sweden
	Input	Refined resource	Thinned forest area	0.0025			ha	Technosphere	Sweden
	Input	Refined resource	Tree seeds	0.0015			kg	Technosphere	Sweden
	Output	Product	Forest land	0.0025			ha	Technosphere	Sweden
	Output	Product	Softwood at roadside	1			m3 fub	Technosphere	Sweden

About Inventory	
Publication	
Intended User	
General Purpose	
Detailed Purpose	
Commissioner	
Practitioner	
Reviewer	
Applicability	
About Data	
Notes	

SPINE LCI dataset: Sinter plant's process ESA-DBP

Administrative	
Finished	Y
Date Completed	1996
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Sinter plant's process ESA-DBP
Functional Unit	1 kg of sinter
Functional Unit Explanation	Unknown
Process Type	Gate to gate
Site	Unknown
Sector	Mining and quarrying
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''A porous mass of sinter are formed from iron ore, limestone and coke breeze. The sinter is more easily reduced than the lump ore.'' This process is included in the system described in: Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Coal mining and cleaning. ESA-DBP - Cast iron production. ESA-DBP - Limestone quarrying. ESA-DBP - Sand extraction and processing. ESA-DBP - Uranium ore extraction and enrichment. ESA-DBP

	- Production of pig iron - blast furnace process. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) and emissions to air and water.
Time Boundary	1982
Geographical Boundary	United Kindom
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1982
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other report.
Literature Reference	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Data for particular process come from: Boustead I. and Hancock G.F. (1982), Energy and Recycling in Steel Production Systems, Resources and Conservation, 9, 209-218, Elsevier Scientific Publishing Company
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Breeze	4.18E-01			kg	Technosphere	United Kingdom
	Input	Natural resource	Iron ore	1.86E+00			kg	Ground	United Kingdom
	Input	Refined resource	Electricity	9.00E-02			MJ	Technosphere	United Kingdom
	Input	Refined resource	Heat	2.33E+00			MJ	Technosphere	United Kingdom
	Input	Refined resource	Limestone	2.24E-01			kg	Technosphere	United Kingdom
	Output	Emission	CO	3.00E-02			kg	Air	United Kingdom
	Output	Emission	NO2	3.00E-04			kg	Air	United Kingdom
	Output	Emission	Particulates	4.50E-04			kg	Air	United Kingdom
	Output	Emission	SO2	2.00E-03			kg	Air	United Kingdom
	Output	Emission	Susp solids	1.00E-05			kg	Water	United Kingdom
	Output	Product	Sinter	1.00E+00			kg	Technosphere	United Kingdom

About Inventory

Publication	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The aim of the study is to undertake an LCA of typical water and sewage pumps. Those aspects which have a major contribution to the environmental impact in the life cycle of a pump will be identified.''
Detailed Purpose	Sinter is an input for pig iron production. Cast iron is a main material in a water pump (90%).
Commissioner	Unknown - .
Practitioner	Johanna Thuresson - .
Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Slow speed, two-stroke diesel vessel engine

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	Swedish Transport Research Board
Availability	Public

Technical System	
Name	Slow speed, two-stroke diesel vessel engine
Functional Unit	1 kWh, 80 % engine load
Functional Unit Explanation	1 kWh mechanical work done by the engine at 80 % engine load
Process Type	Unit operation
Site	Sweden
Sector	Machinery and equipment
Owner	Sweden
Technical system description	Operation of a slow speed, two stroke engine used in Swedish vessels.

System Boundaries	
Nature Boundary	Regulated emissions to air are considered
Time Boundary	The aim was that the data should represent engines in use in 1987.
Geographical Boundary	Engines used in Swedish vessels
Other Boundaries	The engine load i.e the power outtake is 80 %.
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData	
Date Conceived	1989-01-01 - 1990-10-01
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The emissions at 80 % engine load are based on material obtained from engine manufacturers (Wärtsilää Diesel, MaK, MAN -B&W). The material is based on tests performed on the engine installed in a test bench. The data can be found in Alexandersson. The oil consumption is based on assumptions (Alexandersson).
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Heavy oil	200			g	Technosphere	
	Output	Emission	CO	0.2			g	Air	
	Output	Emission	CO2	600			g	Air	
	Output	Emission	HC	0.8			g	Air	
Notes: Data obtained from engine manufacturers varied between 13 and 23 g/kWh.	Output	Emission	NOx	17.7			g	Air	
Notes: Data obtained from engine manufacturers varied between 0,8 and 1.0 g/kWh.	Output	Emission	Particles	0.9			g	Air	

	Output	Product	Mechanical work	1			kWh	Technosphere	

About Inventory	
Publication	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	
General Purpose	
Detailed Purpose	The data was compiled to obtain a basis to calculate the energy use and emissions of average engines installed in Swedish vessels.
Commissioner	- Swedish Transport Research Board, Swedish Maritime Administration, Swedish Shipowner Association, Swedish Environmental Protection Agency, Swedish Port Association and Board for Technical Development.
Practitioner	Alexandersson, Anders - MariTerm Göteborg.
Reviewer	
Applicability	The data was compiled to represent the energy use and emissions of average engines installed in Swedish vessels. The energy use and emissions for different engines may however vary. The data should therefore not be used as a basis to calculate the energy use and emissions of engines installed in international vessels. The emissions of particles and NOx are influenced by the fuel quality, depending on the nitrogen and sulphur content in the fuel. The development of engines has aimed to increase the efficiency of the engine, i.e. decrease the bunker consumption preserving the power outtake. This has resulted in an increase of the specific emissions of NOx, while the emissions of other parameters has decreased.
About Data	The data is compiled using data from engine manufacturers.
Notes	The data was used as a basis to calculate the energy use and emissions for different vessels in the work of NGM published in Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997, NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997

SPINE LCI dataset: Slow speed, two-stroke diesel vessel engine

Administrative	
Finished	Y
Date Completed	1991-01-01
Copyright	Swedish Transport Research Board
Availability	Public

Technical System	
Name	Slow speed, two-stroke diesel vessel engine
Functional Unit	1 kWh, 20 % engine load
Functional Unit Explanation	1 kWh mechanical work done by the engine at 20 % engine load
Process Type	Unit operation
Site	Sweden
Sector	Machinery and equipment
Owner	Sweden
Technical system description	Operation of a slow speed, two stroke engine used in Swedish vessels.

System Boundaries	
Nature Boundary	Regulated emissions to air are considered.
Time Boundary	The aim was that the data should represent engines in use in 1987.

Geographical Boundary	Engines used in Swedish vessels
Other Boundaries	The engine load i.e the power outtake is 20 %.
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1989-01-01 - 1990-10-01
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The emissions at 20 % engine load are based on material obtained from engine manufacturers (Wärtsiläå Diesel, MaK, MAN -B&W). The material is based on tests performed on the engine installed in a test bench. The data can be found in Alexandersson. The oil consumption is based on assumptions (Alexandersson).
Literature Reference	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Oil	200			g	Technosphere	
	Output	Emission	CO	0.06			g	Air	
	Output	Emission	CO2	1000			g	Air	
	Output	Emission	HC	1.3			g	Air	
Method: . Notes: Data from engine manufacturers varied between 13 and 23 g/kWh.	Output	Emission	NOx	17.1			g	Air	
Notes: Data from engine manufacturers varied between 0,8 and 1 g/kWh.	Output	Emission	Particles	0.9			g	Air	
	Output	Product	Mechanical work	1			kWh	Technosphere	

About Inventory

Publication	Alexandersson, A., *Sjöfartens utsläpp av avgaser*, MariTerm, TFB-rapport 1991:18 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	
General Purpose	
Detailed Purpose	The data was compiled to obtain a basis to calculate the energy use and emissions of average engines installed in Swedish vessels.
Commissioner	- Swedish Transport Research Board, Swedish Maritime Administration, Swedish Shipowner Association, Swedish Environmental Protection Agency, Swedish Port Association and Board for Technical Development.
Practitioner	Alexandersson, Anders - MariTerm Göteborg.
Reviewer	
Applicability	The data was compiled to represent the energy use and emissions of average engines installed in Swedish vessels. The energy use and emissions for different engines may however vary. The data should therefore not be used as a basis to calculate the energy use and emissions of engines installed in international vessels. The emissions of particles and NOx are influenced by the fuel quality, depending on the nitrogen and sulphur content in the fuel. The development of engines has aimed to increase the efficiency of the engine, i.e. decrease the bunker consumption preserving the power outtake. This has resulted in an increase of the specific emissions of NOx, while the emissions of other parameters has decreased.
About Data	The data is compiled using data from engine manufacturers.
Notes	The data was used as a basis to calculate the energy use and emissions for different vessels in the work of NGM published in Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997, NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997

SPINE LCI dataset: Smelt iron in a ladle

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Smelt iron in a ladle
Functional Unit	6,59 kg smelt iron
Functional Unit Explanation	6,59 kg smelt iron is used to produce one bearing housing, SNL 511-609, at SKF Mekan AB in Katrineholm. The data in this activity is taken from the LCA of the bearing housing SNL 511-609, and thus it was more convenient to keep this functional unit. The figure 6,59 has nothing to do with guide rings as such.
Process Type	Unit operation
Site	SKF Mekan ABBox 89 641 21 Katrineholm
Sector	Materials and components
Owner	SKF Mekan ABBox 89 641 21 Katrineholm
Technical system description	This activity describes a process step included in the system ''Production of guide rings used for spherical roller bearings'', also available in the SPINE@CPM database. The guide ring is manufactured at SKF Mekan AB in Katrineholm and the process consists of several steps. See the activity ''Production of guide rings used for spherical roller bearings'' for details. The guide ring will finally be mounted into the SKF Spherical Roller Bearing 232/530. The function of the guide ring is to assure that the rollers stay in the raceways of the bearing. After the smelting process, the smelt is transported in a ladle to the furnace to keep it heated. The ladle is preheated through combustion of LPG before use. This activity only describes the pre heating in the ladle and thus the consumption of LPG. The production and combustion of LPG is NOT included in this dataset and should be taken into account in order to obtain the total environmental impact. Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.

System Boundaries	
Nature Boundary	No emissions to air or to water are known.
Time Boundary	The data was collected during the autumn 2002 and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The process takes place at SKF Mekan AB in Katrineholm, Sweden
Other Boundaries	The production and combustion of LPG is NOT included in this study and must be taken into account in order to obtain the total environmental impact.
Allocations	Allocations were made according to weight
Systems Expansions	Not Applicable

Flow Data	
General Activity QMetaData	
Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'
Method	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.

Literature Reference	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Iron	6.590			kg	Technosphere	
	Input	Refined resource	Liquefied petroleum gas	212982			J	Technosphere	
	Output	Product	Iron	6.590			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data set is applicable for the preheating of a ladle at SKF Mekan ABs site in Katrineholm, Sweden.
About Data	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002. The environmental manager Marja Andersson at SKF Mekan AB in Katrineholm has provided information about the specific case with the production of guide rings.
Notes	

SPINE LCI dataset: Smelt iron in a teaming ladle before casting

Administrative

Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System

Name	Smelt iron in a teaming ladle before casting
Functional Unit	6,59 kg smelt iron
Functional Unit Explanation	6,59 kg smelt iron is used to produce one bearing housing, SNL 511-609, at SKF Mekan AB in Katrineholm. This activity is also included in the production of guide rings. The dataset is used unchanged for our specific case, and thus the functional unit is 6,59 kg smelt. The figure 6,59 has nothing to do with guide rings as such.
Process Type	Unit operation
Site	SKF Mekan ABBox 89 641 21 Katrineholm
Sector	Materials and components
Owner	SKF Mekan ABBox 89 641 21 Katrineholm

Technical system description	This activity describes a process step included in the system ''Production of guide rings used for spherical roller bearings'', also available in the SPINE@CPM database. The guide ring is manufactured at SKF Mekan AB in Katrineholm and the process consists of several steps. See the activity ''Production of guide rings used for spherical roller bearings'' for details. The guide ring will finally be mounted into the SKF Spherical Roller Bearing 232/530. The function of the guide ring is to assure that the rollers stay in the raceways of the bearing. After the smelting process, the smelt is transported in a ladle to the furnace to keep it heated. The smelt is then transported in a teaming ladle to the casting process. The different ladles are preheated through combustion of LPG before use. This dataset describes the pre heating of the teaming ladle before the casting process and thus the consumption of LPG. The production and combustion of LPG is NOT included in this dataset and should be taken into account in order to obtain the total environmental impact. Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.

System Boundaries

Nature Boundary	No emissions to air or to water are known.
Time Boundary	The data was collected during the autumn 2002 and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The process takes place at SKF Mekan AB in Katrineholm, Sweden
Other Boundaries	The production and combustion of LPG is NOT included in this study and must be taken into account in order to obtain the total environmental impact.
Allocations	Allocations were made according to weight
Systems Expansions	Not Applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'
Method	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Literature Reference	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Iron	6.590			kg	Technosphere	
	Input	Refined resource	Liquefied petroleum gas	334225			J	Technosphere	
	Output	Product	Iron	6.590			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -

Applicability	The data set is applicable for the preheating of a teaming ladle before the casting process at SKF Mekan ABs site in Katrineholm, Sweden.
About Data	Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002. The environmental manager Marja Andersson at SKF Mekan AB in Katrineholm has provided information about the specific case with the production of guide rings.
Notes	

SPINE LCI dataset: Smelting of iron, type V10

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Smelting of iron, type V10
Functional Unit	6,59 kg smelt iron
Functional Unit Explanation	6,59 kg smelt iron is used to produce one bearing housing, SNL 511-609, at SKF Mekan AB in Katrineholm. The dataset is used unchanged for our specific case (production of guide rings), and thus the functional unit is 6,59 kg smelt. The figure 6,59 has nothing to do with guide rings as such. The smelt iron will finally become a guide ring used in a spherical roller bearing 232/530.
Process Type	Unit operation
Site	SKF Mekan ABBox 89 641 21 Katrineholm
Sector	Materials and components
Owner	SKF Mekan ABBox 89 641 21 Katrineholm
Technical system description	This activity describes a process step included in the system ''Production of guide rings used for spherical roller bearings'', also available in the SPINE@CPM database. Smelting of iron, type V10, is the first process step when producing a guide ring used for the SKF Spherical Roller Bearing 232/530. The function of a guide ring is to assure that the rollers stay in the raceways of the bearing. The raw material is assembled at a storage place outside the plant. It is collected by a traverse and led to the smelting process. The raw material and the alloying substances are divided into the right proportions according to a specific prescription and are then smelted in the electric furnaces. The prescription in this specific case is called V10 and consists of: Pig iron: 3% Steel scrap: 25% Recycled iron: 58% (from their own processes) Steel scrap 14% (from cage manufacturing at SKF Göteborg) Alloying substances are added to give the material the optimal chemical composition. These substances are : Carbomax PK M 1,30% FeMn 0,10% FeS 0,02% Cu 0,07% SiC 1,10% For the smelting process data from bearing housing was used. Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002. , but the ingoing components were changed according to the prescription, type V10, which is used specific for guide rings.

System Boundaries

Nature Boundary	Recycled iron and steel scrap are not considered resources and are not followed from the cradle, but comes from the technosphere. Many of the chemicals used in the process are not followed from the cradle, since it was too time consuming and the impact was assumed to be very small since the total amount and the substances according to product data sheets not were considered hazardous. These inflows are considered non-elementary and come from the technosphere. Emissions to air and water are included.
Time Boundary	The data was collected during the autumn 2002 and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The smelting process takes place at SKF Mekan in Katrineholm, Sweden.
Other Boundaries	Production of Electricity (14 MJ) and District heat (90,1kJ) are NOT included in the data set and should be considered as Swedish average production and followed from the cradle in order to obtain the complete environmental impact. The production of pig iron should be traced from the cradle with the activity ''Production of pig iron'' available in SPINE@CPM database.
Allocations	Allocations have been made according to weight.
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'
Method	Data has been gathered from interviews and supplied material from Marja Andersson, SKF Mekan AB, in Katrineholm. She is responsible for environmental questions and much of the data comes from the environmental report from year 2001. The prescription of the iron in this specific case is called V10 and consists of: Pig iron: 3% Steel scrap: 25% Recycled iron: 58% (from their own processes) Steel scrap 14% (from cage manufacturing at SKF Göteborg) Alloying substances are added to give the material the optimal chemical composition. These substances are : Carbomax PK M 1,30% FeMn 0,10% FeS 0,02% Cu 0,07% SiC 1,10% For the smelting process data from bearing housing was used. Data is taken from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002. , but the ingoing components were changed according to the prescription, type V10, which is used specific for guide rings.
Literature Reference	Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002.
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Al	8.33E-5			kg	Technosphere	
	Input	Refined resource	Aluminium oxide	0.000599			kg	Technosphere	
	Input	Refined resource	Ba	8.33e-005			kg	Technosphere	
	Input	Refined resource	Ca	8.33e-005			kg	Technosphere	
	Input	Refined resource	Carbon	0.08567			kg	Technosphere	
	Input	Refined resource	Cu	0.0046			kg	Technosphere	
	Input	Refined resource	District heat	90109			J	Technosphere	
	Input	Refined resource	Drivibe 400 Z	0.00533			kg	Technosphere	
	Input	Refined resource	Electricity	1.4e+007			J	Technosphere	
	Input	Refined resource	Ferric oxide	5.0E-5			kg	Technosphere	
	Input	Refined resource	Ferromanganese	0.00659			kg	Technosphere	
	Input	Refined resource	FeS	0.0013			kg	Technosphere	
	Input	Refined resource	H2O	1.04e-2			m3	Technosphere	
	Input	Refined resource	Hg	1.6e-8			kg	Technosphere	
	Input	Refined resource	Iron	0.1977			kg	Technosphere	
	Input	Refined resource	Plaster	0.002			kg	Technosphere	
	Input	Refined resource	Potassium oxide	1.33e-4			kg	Technosphere	
	Input	Refined resource	Recycled iron	5.4697			kg	Technosphere	
	Input	Refined resource	Si	5.19E-3			kg	Technosphere	
	Input	Refined resource	SiC	0.07249			kg	Technosphere	
	Input	Refined resource	Silicon dioxide	2.50e-3			kg	Technosphere	
	Input	Refined resource	Sodium oxide	0.000133			kg	Technosphere	
	Input	Refined resource	Steel scrap	0.9226			kg	Technosphere	
	Input	Refined resource	Sulphur	0.000433			kg	Technosphere	
	Output	Emission	Aerosols	1.58e-4			kg	Air	
	Output	Emission	Cd	3.20e-8			kg	Air	
	Output	Emission	Cr	2.12e-7			kg	Air	
	Output	Emission	Cu	4.11e-6			kg	Air	
	Output	Emission	Ni	3.13e-7			kg	Air	
	Output	Emission	Particles	8.19E-4			kg	Air	

	Output	Emission	Pb	7.66e-6			kg	Air	
	Output	Emission	Zn	4.08e-5			kg	Air	
	Output	Product	Iron	6.590			kg	Technosphere	
	Output	Residue	As	8.26e-7			kg	Technosphere	
	Output	Residue	Cd	2.39e-6			kg	Technosphere	
	Output	Residue	Co	7.19e-7			kg	Technosphere	
	Output	Residue	Cr	5.24e-6			kg	Technosphere	
	Output	Residue	Cu	1.46e-5			kg	Technosphere	
	Output	Residue	Grease	2.95e-4			kg	Technosphere	
	Output	Residue	Mn	1.6e-4			kg	Technosphere	
	Output	Residue	Ni	2.84e-6			kg	Technosphere	
	Output	Residue	Particles	0.0287			kg	Technosphere	
	Output	Residue	Pb	1.22e-4			kg	Technosphere	
	Output	Residue	Slag	0.0669			kg	Technosphere	
	Output	Residue	Sulphur	1.21e-4			kg	Technosphere	
	Output	Residue	Zn	4.49e-4			kg	Technosphere	

About Inventory	
Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valid for smelting of iron (and steelscrap) at SKF Mekan AB, Katrineholm. Care needs to be taken for ingoing components, since there are many different prescriptions for cast iron, and the data in this specific case is for the type V10.
About Data	Data is gathered from interviews with Marja Andersson, SKF Mekan AB, Katrineholm. The data for the calculations is obtained from an earlier LCA study of the bearing housing SNL 511-609: Rasmus Beckman and Henrik Olsson; Vilken miljöpåverkan uppstår vid tillverkningen av ett lagerhus?; Master Thesis at Kalmars University; August 2002. Only the ingoing components and alloying substances were changed according to the prescription, type V10, which is used specific for guide rings. For bearing housing another type of iron is smelted: type L10.
Notes	

SPINE LCI dataset: Soil preparation

Administrative	
Finished	Y
Date Completed	1994-02-24
Copyright	None
Availability	Public

Technical System	
Name	Soil preparation
Functional Unit	ha
Functional Unit Explanation	Per hectare of prepared soil to be used for forestry
Process Type	Gate to gate

Site	Middle Sweden
Sector	Forestry
Owner	Middle Sweden
Technical system description	After a clear-cutting of the ground, the soil has to be prepared in order to be planted upon. This is done by mechanically (tractors or specially designed vehicles) removing the topmost layer down to the mineral soil in patches or strips. The planting can also be made on top of the tilted layer.

System Boundaries

Nature Boundary	Emissions caused by diesel combustion is not included in the system.
Time Boundary	An increased use of more efficient machinery would decrease the use of fuels.
Geographical Boundary	Central Sweden
Other Boundaries	N/A
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1992-01-01
Data Type	Unspecified, expert outspoke
Represents	See 'Function'
Method	Soil preparation: Assuming 22,5 l diesel/h is used to prepare 0,5 ha/h, i.e. 45 l diesel/ha, resulting in 1602 MJ/ha (assuming 35,6 MJ/l diesel). According to M. Brindberg.
Literature Reference	Stora forest, M Brindbergs
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1992-01-01 Data type: Derived, unspecified Method: Soil preparation: Assuming 22,5 l diesel/h is used to prepare 0,5 ha/h, i.e. 45 l diesel/ha, resulting in 1602 MJ/ha (assuming 35,6 MJ/l diesel) Literature: M Brindbergs, Stora Skog Notes: According to U Hallonborg, Skogforsk	Input	Refined resource	Diesel	1602			MJ	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: This, the first step in silviculture takes in use a forest area that previously has been in use for forestry or other man-related activities.	Input	Refined resource	Forest land	1			ha	Technosphere	Sweden
Date concieved: 1992-01-01 Data type: Derived, unspecified	Output	Product	Cultivated forest area	1			ha	Technosphere	Sweden

About Inventory

Publication	None -- Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners.
General Purpose	The purpose is to supply with LCA-data for forestry to be used in further studies of wood products.
Detailed Purpose	These data are an update of earlier data on the same subject.
Commissioner	- Stora Corporate Research, Box 601 661 29 Säffle Sweden.
Practitioner	Swan, Göran - Stora Corporate Research, Box 601, S-661 29 Säffle, Sweden.
Reviewer	
Applicability	These data are valid for large scale soil preparation whitin forestry. It is important to check the type of fuel used. In this case, fossil fuel is assumed to be used. Other data is available from other forest companies, or from Skogforsk, or STFI.

	The silviculture process in Sweden has eight steps: 1. Plant nursing 2. Soil preparation 3. Planting 4. Clearing 5. Thinning 6. Fertilizing 7. Final felling 8. Forwarding This is the second step.
About Data	An increased use of more efficient machinery would decrease the use of fuels.
Notes	N/A

SPINE LCI dataset: Solid waste management AGGR

Flow Chart
This data set transparently reported, including a flowchart where each process is individually described

Administrative	
Finished	Y
Date Completed	2002
Copyright	
Availability	

Technical System	
Name	Solid waste management AGGR
Functional Unit	.
Functional Unit Explanation	
Process Type	Gate to grave
Site	Europe
Sector	Waste management
Owner	Europe
Technical system description	This solid waste management system is based on municipal waste: household and commercial waste. A basic sorting activity, which sorts different parts of the waste, is included as well as different treatments. Treatment activities included are: 1. Thermal treatment - Incineration 2. Biological treatment - Composting and Biogasification 3. Landfilling (Material recycling is not included) See the flowchart to see how they are linked. See also the documentation of each of these included subsystems for a further description. Volatile organic compounds included are alcohols, ketones, terpenes, esters, organic sulphides, aldehydes and ethers. Total organic compound for composting and biogasification is 588.5 g/tonne composted biowaste and 3.017 g/tonne of biowaste for biogasifiction. [De Baere, Anaerobic Digestion of Solid Waste: State of Art.Proc. Second International Symposium on Anaerobic Digestion of Solid Waste, Barcelona, 15-18 June, 1999] The partitioning or amount of waste to different treatment plants can differ significantly from region to region. Therefore it is important to know that this aggregated system, Solid waste management, have partitoning based on figures from Renova, Sweden: 12% Biological treatment 13% Recycling 10% Landfilling 65% Incineration [Avfallsmängder till Renovas anläggningar under 2000, www.renova.se]

Flowchart
Click on flowchart to open each data set description

System Boundaries	
Nature Boundary	
Time Boundary	
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	
Represents	See 'Function'
Method	Soil preparation: Assuming 22,5 l diesel/h is used to prepare 0,5 ha/h, i.e. 45 l diesel/ha, resulting in 1602 MJ/ha (assuming 35,6 MJ/l diesel). According to M. Brindberg.
Literature Reference	Stora forest, M Brindbergs
Notes	The suppliers of materials for this product are located in Germany so it was assumed that the origin of these materials is the same.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: Diesel fuel is used in the subsystem Landfilling of solid municipal waste, more information can be found there.	Input	Refined resource	Diesel fuel	138000			l	Technosphere	
Method: See description of functional unit.	Input	Refined resource	Mixed solid waste	230000			tonne	Technosphere	
Method: The following subsystems contribute to the input stream of electricity; Composting of solid municipal waste, Sorting of solid municipal waste and Pre-treatment for biowaste. 265.5 MWh from composting + 712.5 MWh from pre-treatment + 5750 MWh from sorting plant.	Input	Refined resources	Electricity	6727.7			MWh	Technosphere	
Method: Natural gas is used in the subsytem Thermal treatment of solid municipal waste, further informtion can be found there.	Input	Refined resources	Natural gas	34385			m3	Technosphere	
Method: Subsystem Composting of solid municipal waste and Biogasification of solid municipal waste contribute to the emissions of alcohols.	Output	Emission	Alcohols	4041.7			kg	Air	
Method: Subsystem Composting of solid municipal waste and Biogasification of solid municipal waste contribute to the emissions of aldehydes.	Output	Emission	Aldehydes	108.1			kg	Air	
Method: Emissions of heavy metals come from Thermal treatment of solid municipal waste.	Output	Emission	As	1.11			mg	Air	
Method: Emissions of BOD come from the subsystems Composting of solid municipal waste and Biogasification of solid municipal waste.	Output	Emission	BOD	2039			kg	Water	
Method: Emissions of heavy metals come from Thermal treatment of solid municipal waste.	Output	Emission	Cd	4.86			mg	Air	
Method: Emission of CO from the subsystem Thermal treatment of solid municipal waste.	Output	Emission	CO	90.76			tonne	Air	
Method: Emission of CO2 from the subsystem Thermal treatment of solid municipal waste, Landfilling of solid municipal waste, Biogasification of solid municipal waste and Composting of solid municipal waste.	Output	Emission	CO2	180000.3			tonne	Air	
Method: Emissions of COD come from the subsystems Composting of solid municipal waste and Biogasification of solid municipal waste.	Output	Emission	COD	4131			kg	Water	
Method: Emissions of heavy metals come from Thermal treatment of solid municipal waste.	Output	Emission	Cr	6.36			mg	Air	

Method: Emissions of heavy metals come from Thermal treatment of solid municipal waste.	Output	Emission	Cu	37.0			mg	Air	
Method: Emissions of dioxins from the subsystem Thermal treatment of solid municipal waste.	Output	Emission	Dioxin	9.42E-03			kg	Air	
Method: Emissions of esters are from the subsystems Composting of solid municipal waste and Biogasification of solid municipal waste.	Output	Emission	Esters	751			kg	Air	
Method: Emissions of ethers are from the subsystems Composting of solid municipal waste and Biogasification of solid municipal waste.	Output	Emission	Ethers	37.4			kg	Air	
Method: Emission of HCl from the subsytem Thermal treatment of solid municipal waste.	Output	Emission	HCl	29.6			tonne	Air	
Method: Emissions of heavy metals come from Thermal treatment of solid municipal waste.	Output	Emission	Hg	47			mg	Air	
Method: Emissions of ketones are from the subsystems Composting of solid municipal waste and Biogasification of solid municipal waste.	Output	Emission	ketones	2149.8			kg	Air	
Method: Methane is a part of the landfill gas from the subsystem Landfilling of solid municipal waste.	Output	Emission	Methane	1810.56			tonne	Air	
Method: Emission of nitrogen comes from the subsystems Composting of solid municipal waste and Biogasification of solid municipal waste.	Output	Emission	N total	2.14			kg	Air	
Method: N2 is a part of the landfill gas from the subsystem Landfilling of solid municipal waste.	Output	Emission	N2	118.82			tonne	Air	
Method: Emission of NH3 comes from subsystems Composting of solid municipal waste and Biogasification of solid municipal waste.	Output	Emission	NH3	3655.1			kg	Air	
Method: Emissions of NH4+ come from the subsystems Composting of solid municipal waste and Biogasification of solid municipal waste.	Output	Emission	NH4+	1065			kg	Water	
Method: Emissions of heavy metals come from Thermal treatment of solid municipal waste.	Output	Emission	Ni	16.26			mg	Air	
Method: Emissions of NOx come from the subsystem Thermal treatment of solid municipal waste.	Output	Emission	NOx	145.9			tonne	Air	
Method: O2 is a part of the landfill gas from the subsystem Landfilling of solid municipal waste.	Output	Emission	O2	34.04			tonne	Air	
Method: Emission of organic sulphides come from subsystems Composting of solid municipal waste and Biogasification of solid municipal waste.	Output	Emission	Organic sulphides	135.4			kg	Air	
Method: Particles are emissions from the subsystem Thermal treatment of solid municipal waste.	Output	Emission	Particles	17.13			tonne	Air	
Method: Emissions of heavy metals come from Thermal treatment of solid municipal waste.	Output	Emission	Pb	19.31			mg	Air	
Method: Emission of SO2 comes from the subsystem Thermal treatment of solid municipal waste.	Output	Emission	SO2	62.2			tonne	Air	
Method: Emissions of terpenes come from the subsystems Composting of solid municipal waste and Biogasification of solid municipal waste.	Output	Emission	Terpenes	1205.6			kg	Air	
Method: Emissions of heavy metals come from Thermal treatment of solid municipal waste.	Output	Emission	Zn	712.6			mg	Air	
Method: Compost is a product from the subsystems Composting of municipal solid waste and Biogasification of solid municipal waste.	Output	Product	Compost	12504.5			tonne	Technosphere	
Method: The following subsystems contribute to the output stream of electricity; Thermal treatment of solid municipal waste, Biogasification of solid municipal waste and Landfilling of solid municipal waste. 450 kWh/ton incinerated + 140 kWh/ton biowaste to biogasification + 210 kWh/ton waste to landfill = 67275 MWh +1995 MWh + 4830 MWh = 74100 MWh	Output	Product	Electricity	74100			MWh	Technosphere	
Method: Filter dust is residual waste from the subsystem Thermal treatment of solid municipal waste.	Output	Residue	Filter dust	2990			tonne	Ground	

Method: Residual waste comes from the subsystem Landfilling of solid municipal waste, Biogasification of municipal solid waste, Composting of municipal solid waste and Thermal treatment of municipal solid waste.	Output	Residue	Residual waste	23051.75			tonne	Ground		
Method: Slags and ash are residual waste from the subsystem Thermal treatment of solid municipal waste, see this system for more information.	Output	Residue	Slags and ash	1794			tonne	Ground		

About Inventory	
Publication	
Intended User	
General Purpose	
Detailed Purpose	
Commissioner	
Practitioner	
Reviewer	
Applicability	
About Data	
Notes	

SPINE LCI dataset: Solid wood flooring. ESA-DBP

Administrative	
Finished	Y
Date Completed	1994
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Solid wood flooring. ESA-DBP
Functional Unit	1 m2*year flooring
Functional Unit Explanation	Excerpt from the publication (see 'Publication'): ''The purpose of the study was to assess and compare the environmental impact from cradle to grave for floor coverings. The covering of one square metre of flooring during one year of operation was therefore chosen as the functional unit, or basis of comparison.'' 1 m2 of solid wood floor weighs 7.4 kg, including laying waste.
Process Type	Cradle to grave
Site	Not applicable
Sector	Construction
Owner	Not applicable
Technical system description	Excerpt from the publication: ''The life cycle of solid wood flooring. Wood is the only raw material in wood flooring. A production cycle for forestry means that the forest has to be planted, grow, be thinned, be felled, soil-cultivated and re-planted. After cutting, the trees are transported to sawmills, where barking, sawing to the desired dimensions and drying take place. The flooring is then transported to the customer, and laid.'' The flow chart for solid wood flooring can be found at page 249 in the publication. This system is described in: Jönsson et al, 1997, Life cycle assessment of flooring materials: case study. Building and Environment, Vol. 32, No. 3, pp. 245-255.

	Link to pdf: http://cpmdatabase.cpm.chalmers.se/DataReferences/Joensson_et_al_1997.pdf Other processes in the CPM Database also included in the above publication: Linoleum flooring. ESA-DBP Vinyl flooring. ESA-DBP Other processes in the CPM Database connected to the above publication: Dioctyl phthalate (DOP) production. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	Data are applicable to the situation at the time, i.e. 1994.
Geographical Boundary	The scenarios describe a Swedish situation. The solid wood studied was produced in Sweden.
Other Boundaries	The solid wood is untreated. Excerpts from the publication (see 'Publication'): - Floorings for domestic use were studied. - It was assumed for the calculations that there is no recycling or recovery of the flooring materials, and that all materials are incinerated, with energy recovery, after use. - It was assumed that all pigments used consisted of titanium dioxide. - Some additives in the products were used in such small quantities that their environmental impact was disregarded in the study.
Allocations	Excerpt from the publication (see 'Publication'): ''The environmental impact of multi-output processes was allocated in proportion to the physical parameter most closely reflecting the economic value, which in most cases resulted in weight being used. No allocation was made between the two functions of incineration, waste elimination and heat production. Instead, the heat produced was reported as a useful energy flow leaving the systems analysed.''
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	Derived, mixed
Represents	See 'Function'.
Method	Excerpt from the publication (see 'Publication'): ''In this study, the necessary information was gathered from producing companies, authorities and the literature, including other LCA studies.''
Literature Reference	Jönsson et al, 1997, Life cycle assessment of flooring materials: case study. Building and Environment, Vol. 32, No. 3, pp. 245-255. Link to pdf: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/Joensson_et_al_1997.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Calorific value	126			MJ	Technosphere	
Notes: Sawmill.	Input	Refined resource	Electricity	8.37			MJ	Technosphere	
Notes: Transports (74%). Tree felling etc. (26%).	Input	Refined resource	Fossil fuel	5.39			MJ	Technosphere	
Notes: Sawmill (drying process).	Input	Refined resource	Renewable fuel	35.4			MJ	Technosphere	
Notes: Raw material.	Input	Refined resource	Wood	7.4			kg	Technosphere	
Notes: Wood cultivation.	Input	Resource	Forest land	43.9			m2 year	Forestral ground	
Notes: Incineration.	Output	By-product	Recovered energy	113			MJ	Technosphere	
Notes: Sawmill (96%).	Output	Emission	CO	36.8			mg	Air	
Notes: Transports (74%).	Output	Emission	CO2	424			g	Air	
Notes: Transports (74%).	Output	Emission	COD	6.3			mg	Water	
Notes: Transports (48%). Sawmill (36%).	Output	Emission	Dust	1.24			g	Air	
Notes: Transports (85%).	Output	Emission	HC	0.98			g	Air	
Notes: Incineration (64%).	Output	Emission	NOx	31.6			g	Air	
Notes: Transports (74%).	Output	Emission	N-tot	1.03			mg	Water	
Notes: Transports (74%).	Output	Emission	Oil	2.15			mg	Water	
Notes: Transports (74%).	Output	Emission	Phenol	0.03			mg	Water	
Notes: Transports (24%). Sawmill (56%).	Output	Emission	SO2	1.89			g	Air	
Notes: Wood production.	Output	Emission	Terpenes	3.33			g	Air	

	Output	Product	Solid wood flooring	1			m2 year	Technosphere	
Notes: Incineration (75%). Sawmill (25%).	Output	Residue	Ash	198			g	Technosphere	

About Inventory	
Publication	Jönsson et al, 1997, Life cycle assessment of flooring materials: case study. Building and Environment, Vol. 32, No. 3, pp. 245-255. Link to pdf: http://cpmdatabase.cpm.chalmers.se/DataReferences/Joensson_et_al_1997.pdf
Intended User	LCA practitioners.
General Purpose	Excerpts from the publication (see 'Publication'): ''THE consequences of the human impact on the environment have become increasingly clear in recent years. A number of previously unknown environmental problems have emerged at local, regional and global levels, in spite of considerable efforts to decrease environmental emissions from identified point sources. Consequently, demands are now being made on the environmental soundness of products. From industry there is a demand for methods of improving products from the environmental point of view, both for internal use and for marketing purposes. Authorities need methods which can be used to assess the environmental consequences of product related decisions. Life cycle assessment (LCA) is becoming an increasingly important method for making product related environmental assessments.'' ''When applying LCA to building materials and components, special methodological problems arise because of the relatively long lifetime and the complex purpose of these products. Therefore, a project entitled ''Environmental Assessment of Buildings and Building Materials'' has been initiated at the Department of Technical Environmental Planning of Chalmers University of Technology (CTH). The case study of flooring materials presented in this article constitutes the first step in this project.''
Detailed Purpose	Excerpt from the publicatoin (see 'Publication'): ''The environmental impact of three flooring materials during their life cycles was assessed and compared using the LCA method. The objective was to make a specific comparison between the environmental impacts of the life cycle of some flooring materials and to develop a methodology for LCA of building materials.''
Commissioner	Not applicable - .
Practitioner	Jönsson, Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden .
Reviewer	Tillman, Anne-Marie - Environmental Systems Analysis
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpts from the publication (see 'Publication'): '' - The three studied products all have a calorific value and could alternatively be used as fuels. Since the energy recovered from incineration was accounted for as an energy gain, the calorific value of the materials was treated as an energy cost. - Production of electricity was not included in the systems analysed, due to lack of data. Electricity use was thus accounted for only as the amount used. When interpreting the results, the amount of electricity used reflects a number of environmental impacts, including flooded land from hydropower, radioactive waste from nuclear power and emissions to the air from fossil fuel based electricity production. - The environmental impact of cleaning and maintenance was omitted. It was roughly assumed that the cleaning habits are probably independent of what floor covering is used. In addition, no reliable data were available in this area.'' ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-09-15 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Sorting of solid municipal waste

Administrative	
Finished	Y
Date Completed	2002-08-14

Copyright	
Availability	Public

Technical System	
Name	Sorting of solid municipal waste
Functional Unit	230 000 tonne of mixed waste
Functional Unit Explanation	230 000 tonnes of mixed waste containing Municipal solid waste, non-organic material (plastic, glass, metal etc) and organic material. In Sweden one person generates 440 kg household waste/year. A population of 500 000 persons in a urbal area with a generation of 10 000 tonnes of commercial waste/year results in 230 000 tonne of municipal solid waste. Data is based on LCI case studies presented in Integrated Solid Waste Management: a Life Cycle Inventory, F. McDougall, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001.
Process Type	Gate to gate
Site	Europe
Sector	Waste sorting and collection
Owner	Europe
Technical system description	This activity describes a sorting facility. Sorting is an important part of any waste's Life Cycle. Solid waste is almost always mixed, and household wastes are amongst the most heterogeneous in terms of material composition. The earliest sorting will occur in the home then sorting at a Material recovery facility and the sorting of mixed waste to produce refuse-derived fuel are common. Sorting techniques are manual sorting and mechanical sorting. There are three broad categories of mechanical operation: 1. Mechanical disassembly, which separates components physically 2. Separation by particle properties such as size, shape and mass 3. Separation by material property such as magnetism or colour. Common unit processes in mechanical sorting are: Screening, Air classification, Air knife, Sink/float separation, Flotation, Magnetic separation, Electromagnetic separation, Electrostatic separation, Detect and route systems, Roll crushing, Shredding and Baling. Although there is no standard sorting process, an energy consumption of 25 kWh per input tonne is provided in this model as a default value.(McDougall, 2001) Energy consumption depends on which operation and feedstock used. Plant input is often mixed waste, containing Municipal solid waste, non-organic material (plastic, glass, metal etc) and organic material. Mixed waste are passed under a magnet to remove ferrous metals, and then along a conveyor belts where glass bottles, non-ferrous metals and plastic items are hand-picked and recovered. The amount of sorting will depend on the nature of the feedstock, the more narrowly defined the incoming material, the less separation will be required. References: McDougall F. et al, Integrated Waste Management - a Life Cycle Inventory, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001

System Boundaries	
Nature Boundary	No emissions to air, water or ground are included due to lack of data.
Time Boundary	Most data sets are taken from year 2000.
Geographical Boundary	This documentation represents a sorting plant in a European country.
Other Boundaries	
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1992-2001
Data Type	Unspecified
Represents	See 'Function'.
Method	Data sets from Renova in Sweden 2000 have been used to estimate the amount of different fractions of the waste treated in the sorting plant. Electricity data is taken from IWM, McDougall, 2001.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 www.renova.se
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Data type: Unspecified Method: Consumption of electricity is assumed to be 25 kWh per tonne of waste, an average value used in the literature reference based on energy consumption data for materials recovery facilities in Adur in UK, Dublin in Ireland and Prato in Italy. (McDougall, IWM, 2001) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001	Input	Refined resource	Electricity	5750000			kWh	Technosphere	
Date concieved: 2000 Method: See functional unit explanation	Input	Refined resource	Mixed solid waste	230000			tonne	Technosphere	
Date concieved: 2000 Method: The amount of Biowaste is 12% of mixed municipal solid waste. Biowaste is organic waste and non-recyclable paper from households and commercial waste in Sweden (Renova, 2000) Literature: Renova, Återvinnings och avfallsmängder från Renovas anläggningar under 2000, www.renova.se	Output	Product	Biowaste	28500			tonne	Technosphere	
Date concieved: 2000 Method: Waste to incineration is 65% of mixed municipal solid waste. (Renova, 2000). Literature: Renova, Återvinnings och avfallsmängder från Renovas anläggningar under 2000, www.renova.se	Output	Product	Waste to incineration	149500			tonne	Technosphere	
Date concieved: 2000 Method: Waste to landfill is 10% of mixed municipal solid waste. (Renova, 2000) Literature: Renova, Återvinnings och avfallsmängder från Renovas anläggningar under 2000, www.renova.se	Output	Product	Waste to landfill	23000			tonne	Technosphere	
Date concieved: 2000 Method: Waste to material recycling is 13% of mixed municipal solid waste. (Renova, 2000). Literature: Renova, Återvinnings och avfallsmängder från Renovas anläggningar under 2000, www.renova.se	Output	Product	Waste to recycling	29900			tonne	Technosphere	

About Inventory

Publication	Data documented by: Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Documentation reviewed by: Ann-Christin Pålsson, Industrial Environmental Informatics, Chalmers University of Technology Published in SPINE@CPM: 14 August 2002
Intended User	The documentation of this syst
General Purpose	This activity was made to give an indication of sorting of solid waste since data about waste management systems are insufficient and more data are required from the industry.
Detailed Purpose	This acitvity should be used in the aggregated system Solid waste managment to illustrate how sorting of solid waste is performed. The documentation is based on assumption done by the person who made the documentation and data from a Swedish waste management company, Renova. The purpose of the documentation has also been to make data for waste management available in this format for the industry.
Commissioner	
Practitioner	
Reviewer	
Applicability	The amount of sorting needed for specific waste input will depend on the nature of the waste. There are no standard material sorting facility and this activity is aimed to represent an average facility. Also there are no good average values for amount of biowaste, waste to incineration, waste to landfill or waste to material recycling. In this activity, data from Renova in Sweden is used for the different types of waste to different treatments: : 12% Biological treatment 13% Recycling 10% landfilling

	65% Incineration The variations of sorting between different regions and counties in Europe are extensive. To show how amounts of waste to different treatment methods differ some data sets are presented below: Region around Malmö: 5% Composting 38% Recycling 28% landfilling 29% Incineration Vienna, Austria 11% Composting 27% Recycling 31% landfilling 31% Incineration Hampshire, England 6 % Composting 9% Recycling 75% landfilling 10% Incineration
About Data	The descriptions of the activity is how it was understood by the person who made the documentation. Although there are no standard material sorting facility, an energy consumption of 25 kWh/input tonne is provided as an average value, based upon energy consumption data from three different cities in Europe (see QMetaData for further information) No data on emissions were given in the references used.
Notes	For further information about solid waste managment see: Flemström K., Brief overview of solid waste management, IMI-internal report. The report may be downloaded from: http://www.imi.chalmers.se

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SPINE LCI dataset: Soy bean cultivation. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Soy bean cultivation. ESA-DBP
Functional Unit	1 ha of soy bean
Functional Unit Explanation	The study was done for Brazilian soy production. (NB: no information about the amount of the soy bean per ha)
Process Type	Cradle to gate
Site	Unknown
Sector	Crop and animal production, hunting etc.
Owner	Unknown
Technical system description	Soy protein is the only plant protein which is 'complete', in the sense that it provides all the essential amino acids needed for human health. It is low in saturated fat and cholesterol-free. It is extracted from the soy bean, which is cultivated in temperate climates. Most of the Swedish and European soy is imported from Brazil in the form of soy meal and the lion's share of it is used in animal fodder. The most common vegetable sausage alternative is the soy sausage, which in Sweden is marketed by several manufacturers. The soy content usually consists of textured soy protein, which in turn consists of 70% protein and 23% dietary fibres. The concentrate is hydrolysed in order to obtain desirable properties. (...) Using the same yield as in the case of pea protein (65%) an amount of 3.6 kg of soy beans is needed to produce 1 kg of textured soy protein. This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf

	Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Pea-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Pea cultivation. ESA-DBP - Production of beef. ESA-DBP - Production of pork. ESA-DBP - Rape seed cultivation. ESA-DBP - Wheat cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean processing. ESA-DBP

System Boundaries

Nature Boundary	Refined resource and energy use are included in the study.
Time Boundary	The data were acquired in 2004.
Geographical Boundary	The study was done for Brazil.
Other Boundaries	Unknown
Allocations	No information about the allocation in the report.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Unknown
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf The particular data come from: Cederberg, C. & Flysjö, A. (2004). Life Cycle Inventory of 23 Dairy Farms in South-Western Sweden. SIK report no.728. Swedish Institute of Food and Biotechnology (SIK), Gothenburg, Sweden
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Diesel	2.29E+03			MJ	Technosphere	Brazil
	Input	Refined resource	Electricity	1.42E+02			MJ	Technosphere	Brazil
	Input	Refined resource	Heat oil	1.04E+03			MJ	Technosphere	Brazil
	Input	Refined resource	K	5.70E+01			kg	Technosphere	Brazil
	Input	Refined resource	N	8.00E+00			kg	Technosphere	Brazil
	Input	Refined resource	P	3.10E+01			kg	Technosphere	Brazil
	Input	Refined resource	Pesticides	1.50E+00			kg	Technosphere	Brazil
	Output	Product	Soy bean field	1.00E+00			ha	Other	Brazil

About Inventory

Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.''
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .

Practitioner	Anders Abelmann - Chalmers University of Technology.
Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The data for soy bean cultivation were taken from: Cederberg, C. & Flysjö, A. (2004). Life Cycle Inventory of 23 Dairy Farms in South-Western Sweden. SIK report no.728. Swedish Institute of Food and Biotechnology (SIK), Gothenburg, Sweden

SPINE LCI dataset: Soy bean processing. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Soy bean processing. ESA-DBP
Functional Unit	1 ton of processed soy bean
Functional Unit Explanation	
Process Type	Gate to gate
Site	Unknown
Sector	Food products and beverages
Owner	Unknown
Technical system description	Soy protein is the only plant protein which is 'complete', in the sense that it provides all the essential amino acids needed for human health. It is low in saturated fat and cholesterol-free. It is extracted from the soy bean, which is cultivated in temperate climates. Most of the Swedish and European soy is imported from Brazil in the form of soy meal and the lion's share of it is used in animal fodder. (...) The processing of soy beans yields soy meal and soy bean oil. This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Pea-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Pea cultivation. ESA-DBP - Production of beef. ESA-DBP - Production of pork. ESA-DBP - Rape seed cultivation. ESA-DBP - Wheat cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries	
Nature Boundary	Resources, energy use and emissions are included in the study.

Time Boundary	The data were acquired in 2004.
Geographical Boundary	The study was done for Brazil.
Other Boundaries	Unknown
Allocations	No information about the allocation in the report.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from other report.
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf The particular data come from: Cederberg, C. & Flysjö, A. (2004). Life Cycle Inventory of 23 Dairy Farms in South-Western Sweden. SIK report no.728. Swedish Institute of Food and Biotechnology (SIK), Gothenburg, Sweden
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Water	3.28E+00			l	Water	Brazil
	Input	Natural resource	Wood	9.73E+02			MJ	Ground	Brazil
	Input	Refined resource	Electricity	1.66E+02			MJ	Technosphere	Brazil
	Input	Refined resource	Hexane	4.00E-01			kg	Technosphere	Brazil
Notes: NB: Environment not specified in the study	Output	Emission	Hexane	8.00E-05			kg	Other	Brazil
Notes: NB: Environment not specified in the study	Output	Emission	N-N2O	1.70E+00			kg	Other	Brazil
Notes: NB: Environment not specified in the study	Output	Emission	N-NO3	3.60E+01			kg	Other	Brazil
Notes: NB: Environment not specified in the study	Output	Emission	P	3.00E+00			kg	Other	Brazil
	Output	Product	Processed soy bean	1.00E+00			tonne	Other	Brazil

About Inventory

Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.''
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .
Practitioner	Anders Abelmann - Chalmers University of Technology.
Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above

About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The data for soy bean cultivation were taken from: Cederberg, C. & Flysjö, A. (2004). Life Cycle Inventory of 23 Dairy Farms in South-Western Sweden. SIK report no.728. Swedish Institute of Food and Biotechnology (SIK), Gothenburg, Sweden

SPINE LCI dataset: Spain, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Spain, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Spain
Sector	Energyware
Owner	Spain
Technical system description	The generation of electricity with different power generating systems in Spain during the year 1998. Spain includes the Canary Islands.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	10300			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	1352			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	15			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	16212			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	17499			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	2284			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	34005			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas Notes: The value have been corrected after publishing. See Inventory Notes for a description.	Input	Refined resource	Electricity	52866			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	58993			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	193526			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998

	Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	-- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 22 October 2001: <<< Changes made by Ann-Christin Pålsson, CPM: The electricity production by hard coal, coke oven and blast furnace gas have been corrected from 58866 GWh to 52866 GWh according to the original report. The error was identified and reported by Gunnar Mattson, ABB Corporate Research.

SPINE LCI dataset: Stage performance in a theatre. ESA-DBP

Administrative	
Finished	Y
Date Completed	2010
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Stage performance in a theatre. ESA-DBP
Functional Unit	1 sold ticket
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''With the functional unit of one sold ticket, it is possible to compare the opera with the theatre.''
Process Type	Gate to gate
Site	Regionteater Väst
Sector	Arts and entertainment activities
Owner	Regionteater Väst
Technical system description	The study for a stage performance in a theater was done for Regionteater Väst in Uddevalla. The turnover of the theatre in 2009 was 40 million SEK. Excerpt from the report, see 'Publication': ''The theatre is located in a house close to the harbour in Uddevalla, but there exist also a stage in Borås. The house in Uddevalla has two stages (...). Main business focus in Uddevalla is to present scene plays on these two stages as well as going on tours in the western part of Sweden to different rustic sites (bygdegårdar). The main business focus for the house in Borås is to produce dance plays. The Regionteater Väst does not have any restaurant or catering service. They have around 40 employees if both Uddevalla and Borås are accounted. The play 'Plocka potäter i kostym' was chosen by the theatre employees. The criteria for the play were: - Produced for a tour in the western part of Sweden. - Not produced for children. - Possible to collect data for. Therefore, invoices should be possible to find and the staff should remember the play. There were 24 stage performances in the western part of Sweden. Nine people worked specific with the play 'Plocka potäter i kostym' and ten people had worked indirect with it. For example, the office people and the cleaning personal were not possible to link direct to the play.'' In the study except the stage performance itself there were investigated also other processes connected with it. The following activities were considered: office, painting &

	patination and laundry textile, metal workshop, carpentry, props, costume, wig and make up, building maintanance, employee transport, newspaper and recycling of paper and other waste. This process is included in the system described in: Tengström J., Izurieta F. (2010). LCA of Stage Performances. Life Cycle Assessment of an Opera and a Theatre Stage Performance. ESA Report 2010:8, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--8.pdf Other processes in the CPM Database also included in the above publication: Stage performance in an opera. ESA-DBP

System Boundaries

Nature Boundary	In this study the data relates to the activities that take place in the theatre. It contains resource use, but the resources are not tracked to the cradle. The waste for recycling and incineration are considered as an output.
Time Boundary	Excerpt from the report, see 'Publication': ''The data used are from recent years.''
Geographical Boundary	Excerpt from the report, see 'Publication': ''The stage performances are produced in the Regionteater Väst and in the Gothenburg opera. All the customers are in a range of some km up to the whole Sweden. (...) The environmental impacts are considered on an international basis i.e. not only emissions produced in Sweden are accounted. However, the environmental load during use phase and disposal end up in the Swedish waste handling system that can be affected by the decision from the national authorities.''
Other Boundaries	Excerpt from the report, see 'Publication': ''The building construction is included as LCA average data. (...) Site specific data in this study represents the current situation and does not consider the future technical improvements or decisions to handle different materials.''
Allocations	Excerpt from the report, see 'Publication': ''The amount of stage performance times (24 for the Plocka potäter (...)) is divided by the total amount of stage performances.''
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered through interviews, questionnaires, bills' check and analyzing the other reports
Literature Reference	This process is included in the system described in: Tengström J., Izurieta F. (2010). LCA of Stage Performances. Life Cycle Assessment of an Opera and a Theatre Stage Performance. ESA Report 2010:8, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2010--8.pdf
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: in the 'Building data' category	Input	Input Product	Building area	4.20E-03			m2	Technosphere	Sweden
Notes: in the 'Transportation for the tour' category	Input	Input Product	Cars (gasoline with catalyst)	4.47E+00			g	Technosphere	Sweden
Method: Interview Notes: Fashion, 0.08kg/m2, area=0.6237 m2; in the 'Office' category	Input	Input Product	Coloured paper A4	1.70E-02			kg	Technosphere	Sweden
Notes: in the 'Transportation for the tour' category	Input	Input Product	Company car (gasoline)	1.31E+00			pkm	Technosphere	Sweden
Notes: YES; in 'Building maintanance' category, only transport included	Input	Input Product	Detergent for washing dishes	5.00E-04			kg	Technosphere	Sweden
Notes: 0.005kg, 10.5mm x 20.50mm; in the 'Office' category	Input	Input Product	Flyers	1.52E-02			kg	Technosphere	Sweden
Notes: density 1035kg/m3, in 'Building maintanance' category, only transport included	Input	Input Product	Grumme soft soap	4.00E-04			kg	Technosphere	Sweden
	Input	Input Product	Grumme washing powder	6.00E-04			kg	Technosphere	Sweden
Notes: in the 'Wig and make up' category	Input	Input Product	Hairspray without driving gas, Wella	2.30E-04			kg	Technosphere	Sweden
	Input	Input Product	Herdins paint	6.00E-04			kg	Technosphere	Sweden
Notes: 0.15kg, in 'Building maintanance' category	Input	Input Product	Kitchen paper	1.60E-03			kg	Technosphere	Sweden

	Notes: weight 0.011kg, flyer 10.55mm x 20.5mm, in the 'Office' category	Input	Input Product	Letter of invitations	1.30E-03			kg	Technosphere	Sweden
	Notes: in the 'Transportation for the tour' category	Input	Input Product	Mercedes Benz Truck (diesel)	5.80E+03			kgkm	Technosphere	Sweden
	Notes: Abena, 0.4kg; in 'Building maintanance' category	Input	Input Product	Paper for drying hands	5.30E-03			kg	Technosphere	Sweden
	Notes: in the 'Wig and make up' category	Input	Input Product	Plastic cover (assumed polyster)	1.00E-05			kg	Technosphere	Sweden
	Notes: Foot 0.5kg steel, in the category 'Props', plastic assumed to be polyester	Input	Input Product	Plastic trees (150cm, 12st, 2kg)	1.00E-02			kg	Technosphere	Sweden
	Notes: Foot 0.5kg steel, in the category 'Props', plastic assumed to be polyester	Input	Input Product	Plastic trees (180cm, 4st, 5.35 kg)	1.00E-02			kg	Technosphere	Sweden
	Notes: Foot 0.5kg steel, in the category 'Props', plastic assumed to be polyester	Input	Input Product	Plastic trees (210cm, 4st, 6.025kg)	1.00E-02			kg	Technosphere	Sweden
	Notes: Foot 0.5kg steel, in the category 'Props', plastic assumed to be polyester	Input	Input Product	Plastic trees (240cm, 8st, weight 6.7kg)	3.00E-02			kg	Technosphere	Sweden
	Notes: 0.035kg, 60cm x 30cm, 28kg total, in the 'Office' category	Input	Input Product	Posters	1.70E-02			kg	Technosphere	Sweden
	Represents: Assume second hand is used once before and that all is cotton. Notes: density 0.215 kg/m2, in the 'Costume' category	Input	Input Product	Second hand cotton fabrics in clothes	3.80E-03			kg	Technosphere	Sweden
	Notes: Fresh, Level Line, 0.6kg; in 'Building maintanance' category, only transport included	Input	Input Product	Soap	5.00E-04			kg	Technosphere	Sweden
		Input	Input Product	Steel feet to the X-mas trees	1.00E-02			kg	Technosphere	Sweden
	Notes: weight 0.009kg, 30cm x 21cm, in the 'Office' category	Input	Input Product	Theater programs	5.50E-03			kg	Technosphere	Sweden
	Notes: 0.007kg, 7.3cm x 21cm; in the 'Office' category	Input	Input Product	Tickets	7.00E-03			kg	Technosphere	Sweden
	Notes: Vendor, weight 0.35kg, in 'Building maintanance' category	Input	Input Product	Toilet paper	4.70E-03			kg	Technosphere	Sweden
	Notes: in the 'Transportation for the tour' category	Input	Input Product	Train	1.00E-01			pkm	Technosphere	Sweden
	Method: Data from the invoice Notes: Canon, 0.08kg/m2, area 0.12474m2, in the 'Office' category	Input	Input Product	White paper A3	9.00E-04			kg	Technosphere	Sweden
	Method: Interview Notes: Nordic Office, 0.08kg/m2, area=0.06237 m2; in the 'Office' category	Input	Input Product	White paper A4	3.50E-02			kg	Technosphere	Sweden
	Notes: in the 'Transportation for the tour' category	Input	Input Product	Visitor cars (gasoline with catalyst)	1.45E+01			pkm	Technosphere	Sweden
	Notes: in the 'Building data' category	Input	Natural resource	Water	3.00E-02			m3	Water	Sweden
	Notes: density 2700kg/m3, in the 'Forge' category	Input	Refined resource	Aluminium	6.37E-02			kg	Technosphere	Sweden
	Notes: in the 'Wig and make up' category	Input	Refined resource	Aluminium for pressure tube	5.00E-05			kg	Technosphere	Sweden
	Notes: in the 'Building data' category	Input	Refined resource	District heating	2.25E+01			MJ	Technosphere	Sweden
	Notes: in the 'Building data' category	Input	Refined resource	Electricity	2.52E+01			MJ	Technosphere	Sweden
	Represents: assume the density is the same as HP 100% cotton fabric, dimesnion 1.4 meter width Method: Assume all cotton is fabrics, Notes: density 0.215 kg/m2, in the 'Costume' category	Input	Refined resource	New cotton fabrics in cloth	1.50E-03			kg	Technosphere	Sweden
	Notes: density 0.215 kg/m2, in the 'Costume' category	Input	Refined resource	New cotton for own produced pants	5.00E-04			kg	Technosphere	Sweden
	Notes: 4mm, 17m2, density 585kg/m3; in the 'Carpentry' category	Input	Resource	Birch plywood (4mm) 17m2	2.42E-02			kg	Technosphere	Sweden
	Notes: density 380kg/m3, 18% Humidity, in the 'Carpentry' category	Input	Resource	Non-planed spruce	8.70E-03			kg	Technosphere	Sweden
	Notes: density 480kg/m3, 18% Humidity, in the 'Carpentry' category	Input	Resource	Pine (33*69) 17 meter	1.13E-02			kg	Technosphere	Sweden
	Notes: density 480kg/m3, 18% Humidity, in the 'Carpentry' category	Input	Resource	Pine (33*95) 7 meter	6.40E-03			kg	Technosphere	Sweden

Notes: density 380kg/m3, 18% Humidity, in the 'Carpentry' category	Input	Resource	Planed spruce	5.83E-02			kg	Technosphere	Sweden
Notes: density 380kg/m3, 18% Humidity, in the 'Carpentry' category	Input	Resource	Thin cut spruce (28*120) 31 meter	2.09E-02			kg	Technosphere	Sweden
Notes: density 380kg/m3, 18% Humidity, in the 'Carpentry' category	Input	Resource	Thin cut spruce (28*120) 31 meter	2.40E-02			kg	Technosphere	Sweden
	Output	Product	Performance for 1 person	1			pce	Technosphere	Sweden

About Inventory	
Publication	Tengström J., Izurieta F. (2010). LCA of Stage Performances. Life Cycle Assessment of an Opera and a Theatre Stage Performance. ESA Report 2010:8, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--8.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The main reason for carrying out this LCA study is to investigate the environmental impact from a stage performance at the Göteborg Opera and the environmental impact from a stage performance at the Regionteater Väst. The specific questions the study answers are: - How large is the environmental impact from a stage performance in the Regionteater Väst? · How large is the environmental impact from a stage performance in the Göteborg Opera? · How can the environmental impact from the stage performances be reduced? · What happen if the consumption of stage performances increases in society? · Is it environmentally better to consume a stage performance compared to a T-shirt?''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The goal of this study is to investigate the environmental performance of stage performances, more specifically an opera and a theatre stage performance, 'Thaïs' respectively 'Plocka potäter i kostym'. Specific questions the study answers are: · Which processes for the play 'Plocka potäter i kostym' in the Regionteater Väst and which processes for the opera 'Thaïs' in the Göteborg Opera contribute most to the environmental impact? The visitors transportation is put to zero in this accounting LCA. Neither the opera, nor the theatre provides the service of transport the visitors back and forth to the play. · What is worst for the environment from a consumer scenario; consume a stage performance in the Regionteater Väst or in the Göteborg Opera? Here is the transportation of the visitors is included. · What is worst for the environment; consume a stage performance in the Regionteater Väst/the Göteborg Opera or a T-shirt? This is important in a wider perspective, because a choice in the society to consume either services or products could be based on scientific research. The reason to choose a T-shirt as the comparative product is the equality in price to a theater or an opera ticket.''
Commissioner	Region Västra Götaland - .
Practitioner	Francisco Izurieta & Johan Tengström - .
Reviewer	Birgit Brunklaus & Anne-Marie Tillman -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report, see 'Publication': ''The play 'Plocka potäter i kostym' is about the confusing time during the 60s, when the modern world is knocking on the door to countryside. Problems people face are alkohol, love, staying or not staying in the countryside or taking a chance and move to the city for another life.''

SPINE LCI dataset: Stage performance in an opera. ESA-DBP

Administrative	
Finished	Y
Date Completed	2010
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology

Availability	Public

Technical System	
Name	Stage performance in an opera. ESA-DBP
Functional Unit	1 sold ticket
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''With the functional unit of one sold ticket, it is possible to compare the opera with the theatre.''
Process Type	Gate to gate
Site	Göteborg Opera
Sector	Arts and entertainment activities
Owner	Göteborg Opera
Technical system description	The study for a stage performance in an opera was done for Göteborg Opera. The turnover of the opera in 2009 was 400 million SEK. Excerpt from the report, see 'Publication': ''The Göteborg Opera was built in 1994 in the harbor. (...) There are two stages in the house, one big with a bit over 1280 seats and a smaller stage with 230 seats. The opera house also contains a restaurant as well as a café and two bars that serve guests visiting the stage performances. Totally around 450 people are working in the building. (...) The opera chose the play 'Thaïs' suitable to collect data from. The reasons are: -They performance has been performed during year 2009 and year 2010. -The last stage performance was in the spring of year 2010. There were 11 stage performances and around 50 people who were working specific with the play 'Thaïs'. However, more or less the whole opera was indirect working with 'Thaïs'. For example, the office people and the cleaning personal were not possible to link direct to the play. In the study the following activities were included: stage performance, office, marketing, painting workshop, metal workshop, carpentry, scenery, decor, costume, restaurant, wig and make up, building mainatance, employee transport, waste management (paper and burnable waste). This process is included in the system described in: Tengström J., Izurieta F. (2010). LCA of Stage Performances. Life Cycle Assessment of an Opera and a Theatre Stage Performance. ESA Report 2010:8, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--8.pdf Other processes in the CPM Database also included in the above publication: Stage performance in a theatre. ESA-DBP

System Boundaries	
Nature Boundary	In this study the data relates to the activities that take place in the opera. It contains resource use, but the resources are not tracked to the cradle. The waste for recycling and incineration are considered as an output.
Time Boundary	Excerpt from the report, see 'Publication': ''The data used are from recent years.''
Geographical Boundary	Excerpt from the report, see 'Publication': ''The stage performances are produced in the Regionteater Väst and in the Gothenburg opera. All the customers are in a range of some km up to the whole Sweden. (...) The environmental impacts are considered on an international basis i.e. not only emissions produced in Sweden are accounted. However, the environmental load during use phase and disposal end up in the Swedish waste handling system that can be affected by the decision from the national authorities.''
Other Boundaries	Excerpt from the report, see 'Publication': ''The building construction is included as LCA average data. (...) Site specific data in this study represents the current situation and does not consider the future technical improvements or decisions to handle different materials.''
Allocations	Excerpt from the report, see 'Publication': ''The amount of stage performance times ((...)11 for the 'Thais') is divided by the total amount of stage performances.''
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	2010
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Data gathered through interviews, questionnaires, bills' check and analyzing the other reports
Literature Reference	This process is included in the system described in: Tengström J., Izurieta F. (2010). LCA of Stage Performances. Life Cycle Assessment of an Opera and a Theatre Stage Performance. ESA Report 2010:8, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences

	/ESA_2010--8.pdf
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: bought for maximum 700000SEK, 258,6SEK/kg; in the 'Restaurant (1 year)' category	Input	Input Product	Beef	1.09E-02			kg	Technosphere	Sweden
Notes: 13SEK/0,5 liter beer; in the 'Restaurant (1 year)' category	Input	Input Product	Beer	1.71E-02			l	Technosphere	Sweden
Notes: Holgers Stugmaterial, Borås; in the 'Carpenter' category	Input	Input Product	Birch/deal plywood	3.95E-01			kg	Technosphere	Sweden
Notes: Assumed 0,045kg/dinner; in the 'Restaurant (1 year)' category	Input	Input Product	Bread	1.05E-02			kg	Technosphere	Sweden
Notes: in the 'Building data' category	Input	Input Product	Building area	2.60E-03			m2	Technosphere	Sweden
Notes: short distance, hence <20km; in the 'Transportation by their own for this play' category	Input	Input Product	Cars (gasoline with catalyst)	2.25E-01			pkm	Technosphere	Sweden
Notes: Suppliers: Focutex, Pierre Henriet, Schneider & Wahlenberg, Atelje Mode och Bröllop AB, Cavaliera AB, Nanso Group Oy; in the 'Costume' category	Input	Input Product	Cotton fabric	7.70E-03			kg	Technosphere	Sweden
Notes: IImonte AB, in the 'Decor' category	Input	Input Product	Cotton fabrics and carpets	5.80E-03			kg	Technosphere	Sweden
Notes: Suppliers: Cornelia James ltd., Tailor Kontektion; in the 'Costume' category	Input	Input Product	Cotton gloves	1.40E-04			kg	Technosphere	Sweden
Notes: cotton fabrics; in the 'Decor' category	Input	Input Product	Curtain with printed art	4.40E-03			kg	Technosphere	Sweden
Notes: Holgers Stugmaterial, Borås; in the 'Carpenter' category	Input	Input Product	Deal bar order	7.64E-02			kg	Technosphere	Sweden
Notes: Holgers Stugmaterial, Borås; in the 'Carpenter' category	Input	Input Product	Deal shaved	2.60E-02			kg	Technosphere	Sweden
Notes: 100 copies; 0,0005 kg; in the 'Marketing (1 year)' category	Input	Input Product	Drinking tickets	4.00E-07			kg	Technosphere	Sweden
Notes: 260*12, weight 0,37kg (SCA); in the 'Building maintanance (1 year)' category	Input	Input Product	Express paper	4.90E-03			kg	Technosphere	Sweden
Notes: 0,14kg/dinner; in the 'Restaurant (1 year)' category	Input	Input Product	Fish (Cod)	1.02E-02			kg	Technosphere	Sweden
Notes: 5000 copies; 0,002 kg; in the 'Marketing (1 year)' category	Input	Input Product	Flyers	8.00E-04			kg	Technosphere	Sweden
Notes: 60000 copies, 0,234kg; in the 'Marketing (1 year)' category	Input	Input Product	General programs	5.99E-02			kg	Technosphere	Sweden
Notes: assume the truck uses 3.5 liter/10km in the 'Transportation by their own for this play' category	Input	Input Product	Heavy distribution truck	7.37E+01			kgkm	Technosphere	Sweden
Notes: Supplier: Alexander Harr; in the 'Costume' category	Input	Input Product	Leather	1.00E-05			kg	Technosphere	Sweden
Notes: Supplier: Slipskungen; in the 'Costume' category	Input	Input Product	Leather gloves	1.00E-04			kg	Technosphere	Sweden
Notes: 500 copies; 0,017 kg; in the 'Marketing (1 year)' category	Input	Input Product	Letters for invitations	7.00E-04			kg	Technosphere	Sweden
Notes: in the 'Scenery' category	Input	Input Product	Looking equipment in steel for the scene	9.00E-04			kg	Technosphere	Sweden
Notes: assumed 0,1l/dinner; in the 'Restaurant (1 year)' category	Input	Input Product	Milk	2.34E-02			l	Technosphere	Sweden
Notes: in the 'Transportation by their own for this play' category	Input	Input Product	Mini-bus	1.16E-02			pkm	Technosphere	Sweden
Notes: from Örebro, assumed weight 7kg, 75 chairs; in the 'Carpenter' category	Input	Input Product	Old theater chairs in deal	2.04E-02			kg	Technosphere	Sweden
Notes: Divided by the total sold tickets, 0,155kg, around 50 pages; in the 'Marketing (1 year)' category	Input	Input Product	Opera program for Thais	6.01E-02			kg	Technosphere	Sweden
Notes: Office paper, Ricoh Sverige AB; in the 'Office' category	Input	Input Product	Paper	2.16E-02			kg	Technosphere	Sweden
Notes: 288*12/0,62, weight 0,620kg; in the 'Building maintanance (1 year)' category	Input	Input Product	Paper for drying hands	9.10E-03			kg	Technosphere	Sweden
Notes: in the 'Decor' category	Input	Input Product	PC glass	6.55E-01			kg	Technosphere	Sweden
Notes: Suppliers: Akzo Nobel, Hausmann; in the 'Painting' category	Input	Input Product	Plastic paint	4.50E-02			kg	Technosphere	Sweden
Notes: Suppliers: Focutex, Evelin Harren, Alexander Harr, A.Walder & Cie; in the 'Costume' category	Input	Input Product	Polyester fabric	1.50E-03			kg	Technosphere	Sweden

Notes: 0,038 kg; 800 copies; in the 'Marketing (1 year)' category	Input	Input Product	Posters	3.00E-03			kg	Technosphere	Sweden
Notes: Assumed 0,013kg potatoes/erson; in the 'Restaurant (1 year)' category	Input	Input Product	Potatoes	7.50E-03			kg	Technosphere	Sweden
Notes: Supplier: Poly Produkter AB; in the 'Decor' category	Input	Input Product	PP Rope in plastic	3.03E-02			kg	Technosphere	Sweden
Notes: 2100 x 1000 x 2, Suppliers: Andren & Söner, Glasfiber och Plastprodukter AB; in the 'Decor' category	Input	Input Product	PS Plastic mirror gold and dark silver	1.40E-02			kg	Technosphere	Sweden
Notes: 0.1kg/dinner; in the 'Restaurant (1 year)' category	Input	Input Product	Rice	5.30E-03			kg	Technosphere	Sweden
Notes: 0,050kg/dinner; in the 'Restaurant (1 year)' category	Input	Input Product	Salad	1.17E-02			kg	Technosphere	Sweden
Notes: Suppliers: Focutex, New Rainbow, Cloth house; in the 'Costume' category	Input	Input Product	Silk fabric	9.90E-03			kg	Technosphere	Sweden
Notes: Supplier: Creative company; in the 'Costume' category	Input	Input Product	Silk paint	3.00E-04			kg	Technosphere	Sweden
	Input	Input Product	Soap	2.60E-03			kg	Technosphere	Sweden
Notes: 4 times 10 meter with diameter 3mm; in the 'Scenery' category	Input	Input Product	Steel wire	2.00E-04			kg	Technosphere	Sweden
Notes: Assume polystyrene (density 1050kg/m3); in the 'Scenery' category	Input	Input Product	Tamp of plastic	1.30E-03			kg	Technosphere	Sweden
Notes: n the 'Painting' category	Input	Input Product	Tape for painting	2.90E-03			kg	Technosphere	Sweden
	Input	Input Product	Tickets	1.00E-03			kg	Technosphere	Sweden
Notes: 266*6; in the 'Building maintanance (1 year)' category	Input	Input Product	Toilet paper	9.10E-03			kg	Technosphere	Sweden
Notes: 100SEK; in the 'Restaurant (1 year)' category	Input	Input Product	Wine	3.84E-02			l	Technosphere	Sweden
Date concieved: 2009 Notes: in the 'Building data' category	Input	Natural resource	Water	5.72E-02			m3	Water	Sweden
Notes: Supplier: Schneider & Wahlenberg; in the 'Costume' category	Input	Refined resource	Aluminium	2.00E-05			kg	Technosphere	Sweden
Notes: Suppliers: Grimmereds Verkstad AB, HJM-Ett Stena Stälföretag AB, Metallservice AB; in the 'Forge' category	Input	Refined resource	Aluminium	3.76E-02			kg	Technosphere	Sweden
Date concieved: 2009 Notes: in the 'Building data' category	Input	Refined resource	District heating	2.75E+01			MJ	Technosphere	Sweden
Date concieved: 2009 Notes: in the 'Building data' category	Input	Refined resource	Electricity	6.32E+01			MJ	Technosphere	Sweden
Notes: Supplier: HJM-Ett Stena Stälföretag AB; in the 'Forge' category	Input	Refined resource	Steel	2.68E-01			kg	Technosphere	Sweden
	Output	Product	Performance for 1 person	1			pce	Other	Sweden
Notes: Renova, every week; in the 'Waste management' category	Output	Residue	Burnable waste	4.76E-01			kg	Technosphere	Sweden
Notes: Recycled by IL, every 2 weeks; in the 'Waste management' category	Output	Residue	Paper and packaging	3.23E-02			kg	Technosphere	Sweden

About Inventory

Publication	Tengström J., Izurieta F. (2010). LCA of Stage Performances. Life Cycle Assessment of an Opera and a Theatre Stage Performance. ESA Report 2010:8, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2010--8.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The main reason for carrying out this LCA study is to investigate the environmental impact from a stage performance at the Göteborg Opera and the environmental impact from a stage performance at the Regionteater Väst. The specific questions the study answers are: - How large is the environmental impact from a stage performance in the Regionteater Väst? · How large is the environmental impact from a stage performance in the Göteborg Opera? · How can the environmental impact from the stage performances be reduced? · What happen if the consumption of stage performances increases in society? · Is it environmentally better to consume a stage performance compared to a T-shirt?''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The goal of this study is to investigate the environmental performance of stage performances, more specifically an opera and a theatre stage performance, 'Thaïs' respectively 'Plocka potäter i kostym'. Specific questions the study answers are:

	· Which processes for the play 'Plocka potäter i kostym' in the Regionteater Väst and which processes for the opera 'Thaïs' in the Göteborg Opera contribute most to the environmental impact? The visitors transportation is put to zero in this accounting LCA. Neither the opera, nor the theatre provides the service of transport the visitors back and forth to the play. · What is worst for the environment from a consumer scenario; consume a stage performance in the Regionteater Väst or in the Göteborg Opera? Here is the transportation of the visitors is included. · What is worst for the environment; consume a stage performance in the Regionteater Väst/the Göteborg Opera or a T-shirt? This is important in a wider perspective, because a choice in the society to consume either services or products could be based on scientific research. The reason to choose a T-shirt as the comparative product is the equality in price to a theater or an opera ticket.''
Commissioner	Region Västra Götaland - .
Practitioner	Francisco Izurieta & Johan Tengström - .
Reviewer	Birgit Brunklaus & Anne-Marie Tillman -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report, see 'Publication': ''The courtesan 'Thaïs' is standing in the center in Alexandria. Her status as a star is falling. At the same time, the monk Athanaël becomes obsessed to convert her to Christianity. The monk succeeds and 'Thais' leaves her sinful life and starts a new life in a cloister. As time goes by Athanaël realize it is Thais' body he is obsessed with.''

SPINE LCI dataset: Steam cracking in crude oil based LDPE production process. ESA-DBP

Administrative	
Finished	Y
Date Completed	2009
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Steam cracking in crude oil based LDPE production process. ESA-DBP
Functional Unit	1 kg of ethylene
Functional Unit Explanation	1 kg of ethylene is needed to produce 1 kg of LDPE, which was the functional unit for the study.
Process Type	Other
Site	Unknown
Sector	Manufacturing
Owner	Unknown
Technical system description	Steam cracking discussed in this study is one of the steps in crude oil based LDPE (low density polyethylene) production process. This process is gate-to-gate but the electricity and fuel used are traced back to the cradle. In this step naphtha is processed into ethylene. Data for electricity and fuel were calculated for Europe. Excerpt from the report, see 'Publication': ''Steam cracking is the thermal cracking of saturated hydrocarbons into smaller hydrocarbons e.g. ethylene and other olefins, applying steam. In Europe and Asia, the primary raw material for the cracking is naphtha (fraction of the refinery boiling between 35 and 180ºC). For this reason, naphtha is chosen as cracker feed in the study. The cracking process starts with the heating up of the naphtha in a countercurrent flow with flue gases. Then the naphtha is mixed with steam and further heated to 500-680ºC. The temperature depends on its composition. After the heating, the mix flows into a fired tu-bular reactor. It is heated up to 750-875ºC for 0,1-0,5s (while controlling residence time, temperature profile and partial pressure).The naphtha cracks into smaller hydrocarbons mainly ethylene, higher olefins and diolefins.Since this reaction is endothermic, the reaction products have a high temperature. To prevent subsequent reaction they are rapidly

	(0,02-0,1s) cooled down to 550-650ºC, in the so-called quenching step. After the quenching, the products are separated, different separation steps and chem-ical treatments further purify the ethylene.'' This process is included in the system described in: Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2009--14.pdf Other processes in the CPM Database also included in the above publication: - Ethylene production from cane based ethanol. ESA-DBP - Sugarcane cultivation. ESA-DBP - Refinery in crude oil based LDPE production process. ESA-DBP - Polymerization in crude oil based LDPE production process. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''Outputs accounted for in this study were by-products and emissions released to air. Water emissions were omitted, because of data unavailability for some parts of the sugarcane route.'' The data relate also to the fuel and electricity consumption which were traced back to the cradle.
Time Boundary	Data for steam cracking come from 2008 and they were acquired as the most up-to-date ones. Data used for the fuels come from the year 2004.
Geographical Boundary	Process data are valid for Sweden. For electricity calculations the average data from Europe were applied.
Other Boundaries	Excerpt from the report, see 'Publication': ''Assumption set: - total input treated as naphtha - production mix does not change with input composition - conversion rate does not change with input composition - 'make-up' fuel is natural gas coming from Norway - attributional approach - application of average European electricity supply mix data''
Allocations	Excerpt from the report, see 'Publication': ''allocation between ethylene and other products based on weight; ethylene share = 0,6''
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2008
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''The steam cracking was assessed applying data from Borealis, Sweden (2008). The assessment of the electricity supply was done using the already stated data. The consumption of external fuels (natural gas) in the process was assessed according to Bargigli (2004), taking the assumption that that it is Norwegian natural gas.''
Literature Reference	Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2009--14.pdf
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity	4.90E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Fuel	1.50E+01			MJ	Technosphere	Sweden
	Input	Refined resource	Naphtha	1.20E+03			g	Technosphere	Sweden
	Output	Emission	CH4	8.00E-01			g	Air	Sweden
	Output	Emission	CO	1.00E-01			g	Air	Sweden
	Output	Emission	CO2	8.86E+02			g	Air	Sweden
	Output	Emission	HC	4.80E-05			g	Air	Sweden
	Output	Emission	N2O	5.60E-03			g	Air	Sweden
	Output	Emission	NMVOC	8.40E-03			g	Air	Sweden
	Output	Emission	NOx	8.00E-01			g	Air	Sweden
	Output	Emission	SO2	1.40E+00			g	Air	Sweden
	Output	Emission	VOC	5.00E-01			g	Air	Sweden
	Output	Product	Ethylene	1.00E+03			g	Technosphere	Sweden

About Inventory

Publication	Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2009--14.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this study is to answer the question, is the use of sugarcane based LDPE in the production of goods and packing in Sweden environmentally preferable to crude oil based LDPE.''
Detailed Purpose	Steam cracking is a step in the production process of LDPE so it was necessary to investigate the environmental load of it.
Commissioner	Unknown - .
Practitioner	Christin Liptow & Anne-Marie Tillman - Environmental Systems Analysis, Chalmers University of Technology.
Reviewer	Tillman, Anne-Marie - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Steam cracking is a step in a production process of oil based LDPE which was the object of the study. The production process starts with crude oil extraction and is followed by refining, steam cracking, polymerization, use phase (which was excluded from the study) and inceneration as the end of life. Oil based- was compared in the study to the sugarcane based- LDPE. NB: in the report two approaches were investigated: attributional and consequential. For consequential approach see the report.

SPINE LCI dataset: Steam cracking of refined oil products

Administrative	
Finished	Y
Date Completed	1991
Copyright	
Availability	Public

Technical System	
Name	Steam cracking of refined oil products
Functional Unit	1 kg
Functional Unit Explanation	1 kg ethylene.
Process Type	Gate to gate
Site	Statoil Petrokemi AB Stenungsund
Sector	Materials and components
Owner	Statoil Petrokemi AB Stenungsund
Technical system description	The system consists of steam cracking of refined oil products. The process breaks the oil products down into lighter fractions. In the heating process cracking steam is added to the refined oil products (naphtha and propane among others). The products are ethylene and propylene. By-products are among others burning gas, which is used internally as fuel, cracked gasoline and heavy unsaturated hydrocarbons. The various products are separated after the cracking furnaces by destillation, compressing and cooling. The ethylene is piped to the plastic manufacturer so it can be used in the process directly.

System Boundaries

Nature Boundary	In the system only emissions to air and water are accounted for at the nature boundary.
Time Boundary	
Geographical Boundary	
Other Boundaries	Raw material and the energy consumption are accounted for.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1990
Data Type	Unspecified
Represents	See 'Function'
Method	The data are taken from Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992., where they have used data from the environmental report of Statoil Petrokemi AB in Stenungsund
Literature Reference	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992.
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity	1.270			MJ	Technosphere	
	Input	Refined resource	Refined oil products	1.221			kg	Technosphere	Sweden
	Input	Refined resource	Thermal energy	11.603			MJ	Technosphere	
	Output	Emission	CO2	634			g	Air	
	Output	Emission	HC	1.632			g	Air	
	Output	Emission	NOx	0.847			g	Air	
	Output	Emission	N-tot	5.98			mg	Water	
	Output	Emission	Oil	3.83			mg	Water	
	Output	Emission	Phenol	75.36			mg	Water	
	Output	Product	Ethylene	1			kg	Technosphere	

About Inventory

Publication	Tillman, A-M., H Baumann, E. Eriksson, and T. Rydberg, ''Life Cycle Analysis of Selected Packing Materials. Quantification of Environmental Loadings'' Offprint from SOU 1991:77. Chalmers Industriteknik, Göteborg, Sweden 1992. -- Data documented by: Maria Erixon and Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Henrikke Baumann and Anne-Marie Tillman (responsible for the course material) and Ann-Christin Pålsson (responisble for classification of the dataset), Technical Environmental Planning, Chalmers University of Technology --
Intended User	A Life Cycle Assessment practi
General Purpose	The data set are part of a study of ''Packaging and the Environment''.
Detailed Purpose	Exercise material in LCA coarse given at Teknisk Miljöplanering at Chalmers University of Technology, Sweden.
Commissioner	
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden.
Reviewer	
Applicability	The data are valid for Swedish conditions at a specific plant, but can be used as an approximation to other countries and other plants. One should though be aware of the fact that the situation in other countries may be very different and depending on this one gets an unreliable result. The production at Stenungsund Petrokemi is though quite normal for a refinery in general. The data are based on old sources and should therefore not be regarded as information describing the current situation. The emissions from the production of the electricity used in the system is not accounted for.
About Data	

Notes	

SPINE LCI dataset: Steel jointing production

Administrative	
Finished	Y
Date Completed	1997-05-01
Copyright	
Availability	Public

Technical System	
Name	Steel jointing production
Functional Unit	kg
Functional Unit Explanation	1 kg jointing steel
Process Type	Other
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	This data does not represent a technical system. Steel jointing production does not exist in Sweden why the reinforcement steel production is used as an approximation. The environmental load for steel jointing production has been approximated with the one for reinforcement steel. The data for reinforcement steel is to be found in this Database: Name: Swedish reinforcement steel mix Category: Other Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden

System Boundaries	
Nature Boundary	
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	
Data Type	Estimated from similarity
Represents	The environmental load for steel jointing production is approximated with the one for reinforcement steel.
Method	Approximation
Literature Reference	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete Frames; Björklund T., Tillman A-M.; Report 1997:2; TEP; CTH; Göteborg; Sweden
Notes	The environmental load for steel jointing production has been approximated with the one for reinforcement steel. The data for reinforcement steel is to be found in this Database: Name: Swedish reinforcement steel mix Category: Other Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Reinforcement steel	1			g	Technosphere	
	Output	Product	Steel jointings	1			g	Technosphere	

About Inventory	
Publication	LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund, Tillman; Report 1997:2; TEP; CTH; Göteborg; Sweden --- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology ---
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural concrete and steel frames in buildings during the whole life-cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of steel
Commissioner	- Finncement and Trätek (The Swedish Institute for Wood Technology Research) Box 5609 S-114 86 Stockholm Sweden.
Practitioner	Björklund T., Jönsson Å., Tillman A-M - Technical Environmental Planning, CTH Sven Hultins Gata 8 412 96 Göteborg Sweden .
Reviewer	
Applicability	The environmental load for steel jointing production has been approximated with the one for reinforcement steel. The data for reinforcement steel is to be found in this Database: Name: Swedish reinforcement steel mix Category: Other Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden
About Data	
Notes	

SPINE LCI dataset: Steel rail production

Administrative	
Finished	Y
Date Completed	1997-05-01
Copyright	
Availability	Public

Technical System	
Name	Steel rail production
Functional Unit	kg
Functional Unit Explanation	1 kg steel rail
Process Type	Gate to gate
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	At Lindab in Förslöv, thin sheet steel products for buildings, like steel studs, drain pipes, gutters, external sills and other sheet metal work are produced from galvanized sheet steel. Some products are painted or otherwise finished, besides the galvanizing process. The energy use at the plant is low, as none of the process steps has a high-energy demand. Electricity is used for the production process and gas for heating of buildings.

System Boundaries

Nature Boundary	The industrial waste, with the exception of scrap, is used as landfilling and it is considered in this set of data.
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	Estimated from similarity
Represents	The environmental load for steel rail production is approximated with the one for steel studs.
Method	Literature study
Literature Reference	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete Frames; Björklund T., Tillman A-M.; Report 1997:2; TEP; CTH; Göteborg; Sweden
Notes	

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Gas-energy	0.228			MJ	Other	
Notes: The most important chemicals are hydraulic oils, lubricants and defatteners. Chemicals are regarded as a non-elementary flow.	Input	Refined resource	Additives	0.793			g	Technosphere	
	Input	Refined resource	Diesel-energy-precom	0.023			MJ	Technosphere	
	Input	Refined resource	Electricity	0.558			MJ	Technosphere	
	Input	Refined resource	Oil (eo1)	0.216			MJ	Technosphere	
Notes: Thin sheet steel, the raw material used for all products, is bought from several European steel producers. Today SSAB is the main manufacturer. The sheet steel is hot galvanized on both sides.	Input	Refined resource	Sheet steel	1030			g	Technosphere	
	Output	Product	Steel rail	1			kg	Technosphere	
Notes: The hazardous waste mainly consists of hydraulic oils, lubricants, galvanizing baths (chromium) and hydroxide sludge.	Output	Residue	Hazardous waste	0.585			g	Other	
	Output	Residue	Industrial waste	34.9			g	Other	

About Inventory

Publication	LCA of Builing Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete frame; Björklund, Tillman; Report 1997:2; TEP; CTH; Göteborg; Sweden --- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology ---
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural concrete and steel frames in buildings during the whole life-cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of steel rail
Commissioner	- Finncement and Trätek (The Swedish Institute for Wood Technology Research) Box 5609 S-114 86 Stockholm Sweden.
Practitioner	Björklund T., Jönsson Å., Tillman A-M - Technical Environmental Planning, CTH Sven Hultins Gata 8 412 96 Göteborg Sweden .
Reviewer	

Applicability	The environmental load for steel rail production is approximated with the one for steel studs. It is possible through this Database to calculate the environmental load, from cradle to gate, including the sheet steel production. You can find the data for sheet steel production at: Name: Swedish Sheet steel mix Category: Other Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden
About Data	The environmental load from painting and finishing is excluded, since these process steps are not relevant for the steel studs. Average scrap production amounts to about 3% of the production volume. As the scrap is reused it is regarded as a low-grade product. Emissions to air and water There are no significant process emissions to air and water. In the calculations, emission factors are applied for the fossil fuels.
Notes	

SPINE LCI dataset: Steeping of gas tanks

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Steeping of gas tanks
Functional Unit	ton
Functional Unit Explanation	1 ton steeped tank
Process Type	Gate to gate
Site	AGA-CRYO AB Box 8887 47272 Göteborg
Sector	Materials and components
Owner	AGA-CRYO AB Box 8887 47272 Göteborg
Technical system description	The company steeps stationary and mobile tanks used for liquid gas. The operation consists of steeping and coupling in brass and non-corrosive goods, after soldering with non-cadmium plummet. Also alkaline degreasing with organik solvent is part of the process. The steeping process consist of four steps. 1. The goods are immersed in to a steep bath, with low acid concentration, for 3-4 h. 2. The goods are immersed in to a steep bath, with high acid concentration, one or a couple of times. 3. The goods are rinsed in a tub, with warm water. 4. The goods are flushed with a high-pressure washing appliance. The fourth step is done mostly to clean the unsteeped parts of the goods. Because of the rinsing of the steeped goods the remaining parts of the steep bath are thined down to a negligible concentration. The rinsing and flushing water is continiously pumped through the neutralisation to the slam tub.

System Boundaries	
Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	The environmental load for steel rail production is approximated with the one for steel studs.
Method	Study the environmental report
Literature Reference	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Wooden and Concrete Frames; Björklund T., Tillman A-M.; Report 1997:2; TEP; CTH; Göteborg; Sweden
Notes	The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: The solution has the concentration of 62% HNO3	Input	Refined resource	Nitric acid	0.56			tonne	Technosphere	
Date concieved: 1996 Data type: Estimated Method: The amount is founded on a estimation Notes: The oil waste is transported and admitted by RECI	Output	Residue	Hazardous waste	0.025			m3	Technosphere	
Date concieved: 1996 Data type: Estimated Method: The amount is founded on a estimation Notes: The waste contains antimon, arsenik, barium, berylium, bly, kobolt, koppar, krom, nickel, selen, silver, tallium, tenn, vannadin eller zink. It is not specified which of the substances that actually are elements in the waste. The waste is transported and admitted by RECI.	Output	Residue	Hazardous waste	0.75			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: Unspecified Notes: The solution has the concentration of 25% NaOH.	Output	Residue	Sodium hydroxide	0.35625			tonne	Technosphere	
Date concieved: 1996 Data type: Estimated Method: The amount is founded on a estimation Notes: The waste is not specific for the line of business.	Output	Residue	Waste	11.25			tonne	Technosphere	

About Inventory

Publication	The environmental report from AGA-CRYO AB for 1996, The Environmental Administration in the municipality of Göteborg. -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Hoffenback, Rune - AGA-CRYO AB Box 8887 47272 Göteborg .
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	The company used warm water, which is not specified in the environmental report. The pump used by the company most probably needs some sort of energy to be in operatioon. No energy use is mentioned.
About Data	
Notes	

SPINE LCI dataset: Stone coal electricity energy system, EPD-version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Stone coal electricity energy system, EPD-version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures are based on data from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996 and adapted to the demands of the EPD-guidelines (Environmental Product Declaration guidelines in Sweden). -- Brief description -- The main phases inventoried in ETH's life cycle study of electricity generation with stone coal are: mining of coal (open pit and underground), processing I, processing II, transports, storage, power plant operation. Data has been aquired from literature and figures concerning consumption of energyware and materials, use of land and water, emissions to air (also radioactive) and water and wastes have been picked out from or calculated based on literature for all phases of the life cycle. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle. -- Detailed description -- Mining and processing I The prospecting of coal implies test drillings etc but is not inventoried separatly since only a few millimeters of drilling per tonne coal is needed. Production of explosives used is included. Radioactive radon, methane and particles are process specific emissions to air and subsoilwater to water. Open pit mining (28% of used stone coal in UCPTE) is used when the coal is found at a depth of a few to 500 meters. The subsoil water level must be lowered below the seam. Mainly diesel driven mobile machines are used. Underground mining (72% of used stone coal in UCPTE) involves the construction of shafts and galleries and the use of mainly electric hoists etc. Typical coal depths are 100-1200 meters. Emitted methane is partly used as fuel. Air condition and cooling plants are included. The average loss of extracted coal in the mechanic processing plant is assumed to be 30% of the weight for open pit mines and 40% of the weight for underground mines. The assumed average energetic loss however is 5% and 8% respectively. The advantages of processing is for example higher heating value, lower sulphur content, less transports and better furnace conditions. All stone coal is supposed to be processed in this study. Construction and operation of mines and processing plants are inventoried. Demolition processes are assumed to be neglectable, transports and deposit areas are however included. Processing II Most of the coal used in power plants in the UCPTE is steam coal coming directly from the first processing plant but in Germany also coke is used (about 18 % of the use in UCPTE). In the cokery coal is degassed in four steps at increasing temperatures. The products are several, coke typically 79% by weight. The cokery is assumed to be supplied with coke gas. Construction phase and area use has been estimated. Transports and storage Transports of stone coal from 6 supply regions have been inventoried regarding distances, vehicles and transshipment. Coal losses and emissions of particles (relatively large) during transport have been estimated. Coal storages are included, their emissions to air and

	leaching water (rough figures). Coal storages emit CO2 due to oxidation of coal, these emission are assumed to happen in the power plant in the ETH calculations. Construction and scrapping of vehicles are included. Power plant Construction and area use has been inventoried for two standard plants (100 and 500 MWe). The smaller standard plant is equiped with electrofilter and wet desulphuring with lime or limestone, the larger plant has a SCR de-NOx device as well. 90% of the UCPTE stone coal power plants are assumed to belong to the 500 MWe class. The plants are medium load power plants with an average of 4000 h of operation per year. Furnace technology is conventional (i.e. no gasifyers or fluid beds). Average efficiencies of power plants have been calculated (35.7%) based on national statistics. Incoming coal to the UCPTE power plants (average heating value 25,1 MJ/kg) is mixed, grinded and dried. Furnace temperatures of 1,300°C giving fly ashes or 1,600°C leading to ash melting are used. Concerning conventional emissions to air national statistics and bottom-up calculations based on existing UCPTE power plants have been used. Emissions of trace elements are estimated and other emissions are calculated based on literature data. Oil-fuelled starting plant is included. Leaching of substances from deposited ashes is included. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries

Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH. Vattenfall's criterion in selecting and aggregating ETH's LCI-results for electricity generation in the UCPTE region has been to make the figures usable as general electricity LCI data in EPDs according to Miljöstyrningsrådets guidelines. Especially parameters (emissions) which have established impact indices - accepted by the EPD system - for one or several environmental impact categories, have been picked out and aggregated as far possible. But also metal and energyware resources have been included, as well as waste, in spite of all waste handling processes related to this dataset being included with respect to use of resources and emissions. The latter is an adaption to other LCI data for electricity generation where waste amounts are reported (since those flows have not been followed to the grave). Since ETH claimes that most of the figures regarding metal emissions have an undefined amount of datagaps all metal emissions are aggregated except for a few which are specified separatly since they are reported for most processes in the lifecycle. Metals are reported as elements although they often are part of compounds. Measuring methods often just give the amounts of the different elements found. All hydrocarbons to water are aggregated to one parameter as well as halogenated organics, since no indices exist (that are accepted by the EPD system so far) for characterisation of the individual substances.
Time Boundary	Most background data refer to the period 1990 to 1994. Concerning flue gas cleaning equipment data from 1995/96 has been used where possible. Figures regarding use of materials and mining and processing of coal are older which probably doesn´t affect the result much. Future emissions from deposits for filter ashes are included. The amounts of imported coal to the UCPTE are based on the year 1993. Power plant operation is based on the year 1994. Electricity used during the lifecycle has been assumed to be a mix based on the average generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years). All processes, also those conducted in the past, have been assumed to use average technology of the early nineties. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Equipment in mines 30 years Cokery 30 years Power plant 40 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	Figures are based on average stone coal power plants in Austria, Belgium, Spain, Italy, Ex-Jugoslavia, France, Netherlands, Portugal, and Germany. The emphasis concerning the inventory of coal mining is the UCPTE but also North and South America, South Africa, Australia&The Far East and Eastern Europe have been regarded since those regions export hard coal to the UCPTE. About 45% of stone coal used in UCPTE power plants is imported from those other regions.

	Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of ressources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	Data concerning material and energyware use in the construction phase of the mine are rough estimates based on a few real mines. Process specific (i.e. not energyware related) emissions to air from mines have not been included except for radon, methane and particles. The flow of substances in subsoil water is not complete and emissions due to leaching from heaps are rough estimates which probably has an influence on the results. Use and emissions of lubricating and hydraulic oil is not included. Emissions of N2O, dioxines and radioactive substances from cokeries are not included (emissions of other greenhouse gases, hydrocarbons (also aromatic), heavy metals and inorganic substances are included). No accidents were considered in the cokery. Emissions of heavy metals found in emitted particles during transport of coal has not been considered. Emissions of benzene, toluol and xylol from long-time coal storages are not included (emissions of heavy metals and hydrocarbons to water are however included). Accidents are not considered in the power plant. Most data concerning the power plant are based on assumptions and estimates. Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. The ETH study comprises figures concerning use of land, usable content in water storages and amount of turbine water which have not been reported here. The two latter have been excluded due to lack of corresponding data in comparable studies. Use of land has been excluded here because of ETH's advanced approach. Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the indutrial revolution I Modified human impact larger than other species', low degree of culivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of intererst. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is diffrent from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH specifies about 160 radioactive isotopes emitted to air and water. Radioactive emissions reported here are picked out in accordance with SETAC working group report on data quality and data availability (to be published in 2001). Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	Allocation in the cokery between the products have been studied according to energy content, weight and price. The results gave an allocation of 76-83% on the coke. In the ETH study 80% has been allocated to coke. The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average electricity generation with stone coal in the UCTPE countries.

Method	The data has been adapted from the Ökoinventare von Energiesystemen, ETH Zürich 1996 and is an aggregation of the LCI results for the module ''Electricity stone coal power plant UCPTE'' (Strom ab Steinkohlekraftwerk UCPTE-Mix).
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Bauxite	17.8			kg	Ground	
	Input	Natural resource	Chromium in ore	1.09			kg	Ground	
	Input	Natural resource	Copper in ore	4.28			kg	Ground	
Notes: From drillhole	Input	Natural resource	Crude oil	2580			kg	Ground	
Notes: Before processing	Input	Natural resource	Hard coal	183000			kg	Ground	
	Input	Natural resource	Iron in ore	856			kg	Ground	
	Input	Natural resource	Lead in ore	0.25			kg	Ground	
Notes: Before extraction	Input	Natural resource	Lignite	1950			kg	Ground	
	Input	Natural resource	Limestone	2210			kg	Ground	
	Input	Natural resource	Manganese in ore	0.783			kg	Ground	
Notes: Summation of ''Erdoelgas'' (40,9 MJ/Nm3), ''Grubengas'' (35,9 MJ/kg) and ''Rohgas'' (35 MJ/Nm3). Expressed as Natural gas with lower heating value (35 MJ/Nm3). The heating values are acquired from table III 8.1 in the methodology chapter in the Ökoinventare von Energiesystemen, ETH, Zürich 1996	Input	Natural resource	Natural gas	1898			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.377			kg	Ground	
	Input	Natural resource	Palladium in ore	4.70E-07			kg	Ground	
	Input	Natural resource	Platinum in ore	5.39E-07			kg	Ground	
	Input	Natural resource	Rhodium in ore	5.01E-07			kg	Ground	
	Input	Natural resource	Rock salt	52.4			kg	Ground	
	Input	Natural resource	Uranium in ore	0.133			kg	Ground	
	Input	Natural resource	Water	1.07E+07			kg	Ground	
	Input	Natural resource	Wood	1320			kg	Ground	
	Input	Natural resource	Zinc in ore	0.0396			kg	Ground	
Notes: Summation of Ag, Sn, Rh, Mo, Co.	Input	Refined resource	Metals	1.26E-02			kg	Technosphere	
	Output	Emission	1,2-Dichloroethane	7.80E-05			kg	Air	
	Output	Emission	Ag-110m	0.374			kBq	Water	
	Output	Emission	Ag-110m	5.48E-05			kBq	Air	
	Output	Emission	Am-241	0.135			kBq	Water	
	Output	Emission	Am-241	1.02E-03			kBq	Air	
Notes: BOD5	Output	Emission	BOD	1.31E-01			kg	Water	
	Output	Emission	C-14	6.81			kBq	Water	
	Output	Emission	C-14	82.4			kBq	Air	
	Output	Emission	C-60	2.32E-03			kBq	Air	
	Output	Emission	Cd	1.58E-02			kg	Water	
	Output	Emission	Cd	1.79E-03			kg	Air	
	Output	Emission	Cd	3.95E-06			kg	Ground	
	Output	Emission	CFC-11	4.21E-05			kg	Air	
	Output	Emission	CFC-114	1.11E-03			kg	Air	
	Output	Emission	CFC-12	9.05E-06			kg	Air	

	Output	Emission	CFC-13	5.68E-06			kg	Air	
	Output	Emission	Cm alpha	0.178			kBq	Water	
	Output	Emission	Cm alpha	1.62E-03			kBq	Air	
	Output	Emission	Cm-244	4.89E-08			kBq	Air	
Notes: CN- is Cyanide ion	Output	Emission	CN-	2.51E-04			kg	Air	
	Output	Emission	CN-	4.16E-03			kg	Water	
	Output	Emission	CO	56.6			kg	Air	
	Output	Emission	CO2	275833			kg	Air	
	Output	Emission	Co-58	0.597			kBq	Water	
	Output	Emission	Co-58	1.56E-03			kBq	Air	
	Output	Emission	Co-60	29.826			kBq	Water	
	Output	Emission	COD	1.1799			kg	Water	
	Output	Emission	Cr	2.92E+00			kg	Water	
	Output	Emission	Cr	3.31E-02			kg	Air	
	Output	Emission	Cr	7.87E-04			kg	Ground	
	Output	Emission	Cs-134	3.88E-02			kBq	Air	
	Output	Emission	Cs-134	6.8877			kBq	Water	
	Output	Emission	Cs-137	0.075			kBq	Air	
	Output	Emission	Cs-137	63.478			kBq	Water	
	Output	Emission	Dichloromethane	2.38E-04			kg	Air	
Notes: 2,3,7,8-Tetrachlorodibenzo-p-Dioxin-equivalents	Output	Emission	Dioxin (TCDD)	17000			ng	Air	
	Output	Emission	Dissolved solids	124.3			kg	Water	
	Output	Emission	H-1301	1.00E-03			kg	Air	
	Output	Emission	H2S	0.05237			kg	Air	
	Output	Emission	H-3	2.02E+05			kBq	Water	
	Output	Emission	H-3	847			kBq	Air	
Notes: Summation of AOX, 1,1,1-trichloroethane, chlorobenzene, dichloromonofluoromethane, ethylene dichloride, hexachlororethane, metylenchloride, tetrachloroethylene, trichloroethylene, trichloromethane.	Output	Emission	Halogenated organics	1.74E-03			kg	Water	
Notes: Summation of Cl-, F- and I-.	Output	Emission	Halogenids	1.86E+03			kg	Water	
Notes: Summation of I and Br.	Output	Emission	Halogens	6.48E-01			kg	Air	
	Output	Emission	HCFC-21	1.81E-03			kg	Air	
	Output	Emission	HCFC-22	9.92E-06			kg	Air	
	Output	Emission	HCl	59.9341			kg	Air	
Notes: No available index. Same index as NMVOC.	Output	Emission	Hexachlorobenzene	2.90E-09			kg	Air	
	Output	Emission	Hexafluoroethane	1.93E-04			kg	Air	
	Output	Emission	HF	10.3091			kg	Air	
	Output	Emission	HFC-134a	9.95E-17			kg	Air	
	Output	Emission	Hg	3.25E-02			kg	Air	
	Output	Emission	Hg	3.75E-04			kg	Water	
	Output	Emission	Hg	5.96E-07			kg	Ground	
Notes: Summation of acenaphtene, acenaphtylene, alkane, alkene, aromats, benzene, butyl benzyl phtalat, bibutyl p-phtalat, dimethyl p-phtalat, ethylbenzen, volatile hydrocarbons, formaldehyd, glutaraldehyd, hydrocarbons, MTBE (Metyl Tertiary Butyl Eter), phenol, styrol, toluol, triethylenglycol, xylol.	Output	Emission	Hydrocarbons	2.18E-01			kg	Water	
	Output	Emission	I-129	0.292			kBq	Air	
	Output	Emission	I-129	19.5			kBq	Water	
	Output	Emission	I-131	0.013			kBq	Water	
	Output	Emission	I-131	0.033			kBq	Air	
	Output	Emission	I-133	0.00325			kBq	Water	
	Output	Emission	I-133	0.0181			kBq	Air	
	Output	Emission	K-40	15.7			kBq	Air	
	Output	Emission	K-40	61.3			kBq	Water	
	Output	Emission	Kr-85	5.03E+06			kBq	Air	
Notes: Summation of the ions of following metals: Ag, Al, Ar, Ba, Be, Cs, Ca, Fe, K, Co, Mg, Mn, Mo, Na, Ni, Ru, Sb, Se, Sn, Sr, Ti, W.	Output	Emission	Metal ions	1.32E+03			kg	Water	
Notes: Summation of Al, As, Ca, Co, Cu, Fe, Mn, Ni, Sn.	Output	Emission	Metals	1.11E+00			kg	Ground	

Notes: Summation of Al, As, Ba, Be, Ca, Co, Cu, Fe, K, La, Mg, Mn, Mo, Ni, Pt, Sb, Sc, Se, Sn, Sr, Th, Ti, Tl, U, Zr.	Output	Emission	Metals	2.24E+01			kg	Air	
	Output	Emission	Methane	1003.505			kg	Air	
	Output	Emission	Mn-54	4.5679			kBq	Water	
	Output	Emission	Mn-54	5.57E-05			kBq	Air	
	Output	Emission	N	1.71E-04			kg	Ground	
	Output	Emission	N total	0.71417			kg	Water	
	Output	Emission	N2O	1.7916			kg	Air	
	Output	Emission	NH3	1.49737			kg	Air	
Notes: Summation of acetaldehyd, acetylene, aceton, acrolein, aldehyd, alkane, alkene, aromats, benzaldehyd, benzene, butan, buten, acetic acid, etan, etanol, etene, ethylbenzene, ethylenoxide (C2H4O), formaldehyd, heptan, hexan, metanol, MTBE (Metyl Tertiary Butyl Eter), NMVOC, pentane, phenol, propan, propen, propion aldehyd, propionic acid, styrol, toluol, xylol.	Output	Emission	NMVOC	3.39E+01			kg	Air	
	Output	Emission	NO2-	5.22E-03			kg	Water	
	Output	Emission	NO3-	5.3812			kg	Water	
Notes: as NO2	Output	Emission	NOx	451.7			kg	Air	
	Output	Emission	Np-237	0.0086			kBq	Water	
	Output	Emission	Oil	1.66E-01			kg	Ground	
	Output	Emission	Oil	2.55E+00			kg	Water	
	Output	Emission	P	0.00822			kg	Ground	
	Output	Emission	P total	1.34E-01			kg	Air	
	Output	Emission	PAH	1.78E-03			kg	Water	
Notes: Same index as NMVOC.	Output	Emission	PAH	3.52E-03			kg	Air	
	Output	Emission	Particles	321.59			kg	Air	
	Output	Emission	Pb	1.48E+00			kg	Water	
	Output	Emission	Pb	6.59E-02			kg	Air	
	Output	Emission	Pb	8.04E-05			kg	Ground	
	Output	Emission	Pb-210	48.8			kBq	Water	
	Output	Emission	Pb-210	55.261			kBq	Air	
Notes: C6HCl5, no available index. Same index as NMVOC.	Output	Emission	Pentachlorobenzene	7.76E-09			kg	Air	
Notes: C6HCl5O, no available index. Same index as NMVOC.	Output	Emission	Pentachlorophenol	1.25E-09			kg	Air	
	Output	Emission	Po-210	100.361			kBq	Air	
	Output	Emission	Po-210	48.8			kBq	Water	
	Output	Emission	PO43-	1.75E+01			kg	Water	
	Output	Emission	Pu alpha	0.00324			kBq	Air	
	Output	Emission	Pu alpha	0.535			kBq	Water	
	Output	Emission	Pu-238	1.22E-07			kBq	Air	
	Output	Emission	Ra-226	15.22			kBq	Air	
	Output	Emission	Ra-226	2521.5			kBq	Water	
Notes: Long-term emissions of Rn-222	Output	Emission	Rn-222	7.22E+06			kBq	Air	
	Output	Emission	Rn-222	8.11E+04			kBq	Air	
	Output	Emission	Ru-106	0.324			kBq	Air	
	Output	Emission	Ru-106	32.4			kBq	Water	
	Output	Emission	S	0.0945			kg	Ground	
Notes: Includes Tot-S, S-, S in H2S, S in sulphate, S in sulphite	Output	Emission	S total	4.24E+02			kg	Water	
	Output	Emission	Sb-124	0.0968			kBq	Water	
	Output	Emission	Sb-124	1.51E-05			kBq	Air	
	Output	Emission	Sb-125	0.0058			kBq	Water	
	Output	Emission	Sb-125	1.97E-06			kBq	Air	
	Output	Emission	SO2	1062.07			kg	Air	
	Output	Emission	Sr-90	0.0536			kBq	Air	
	Output	Emission	Sr-90	6.49E+00			kBq	Water	
	Output	Emission	Suspended solids	10.77			kg	Water	
	Output	Emission	Tc-99	2.27E-06			kBq	Air	
	Output	Emission	Tc-99	3.41			kBq	Water	
	Output	Emission	Tetrachloromethane	5.78E-05			kg	Air	
	Output	Emission	Tetrafluoromethane	0.00174			kg	Air	
	Output	Emission	Th-230	0.361			kBq	Air	
	Output	Emission	Th-230	94			kBq	Water	
	Output	Emission	Th-232	11.4			kBq	Water	
	Output	Emission	Th-232	4.13			kBq	Air	

Notes: Summation of dissolved organic carbon, fat acids as C, volatile organic compounds as C, TOC.	Output	Emission	Total organic carbon	5.79E+00			kg	Water	
	Output	Emission	Tributyl tin	5.54E-03			kg	Water	
	Output	Emission	Trichloromethane	2.06E-06			kg	Air	
	Output	Emission	U-234	0.389			kBq	Air	
	Output	Emission	U-234	0.804			kBq	Water	
	Output	Emission	U-235	0.0189			kBq	Air	
	Output	Emission	U-235	1.2			kBq	Water	
	Output	Emission	U-238	12.184			kBq	Air	
	Output	Emission	U-238	25.7			kBq	Water	
	Output	Emission	V	1.47E+00			kg	Water	
	Output	Emission	V	1.86E-01			kg	Air	
	Output	Emission	Vinyl chloride	1.27E-05			kg	Air	
	Output	Emission	Xe-133	3610			kBq	Air	
	Output	Emission	Zn	1.13E-01			kg	Air	
	Output	Emission	Zn	2.54E-03			kg	Ground	
	Output	Emission	Zn	2.96E+00			kg	Water	
	Output	Product	Electricity	1			TJ	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) and processing of hazardous waste is included.	Output	Residue	Hazardous waste	2.45E+01			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Highly radioactive waste	2.27E-05			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, no emissions from landfill assumed. Inert waste deposit is waste at landfill that are inert.	Output	Residue	Inert waste deposit	6.05E+04			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Low radioactive waste	6.59E-04			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Medium and low radioactive waste	2.78E-04			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from landfill. Reactive waste deposit is waste at landfill that is still reactive.	Output	Residue	Reactive waste deposit	5.27E+03			kg	Technosphere	
Notes: Internal flow! Infrastructure of spreading vehicles and emissions are included. Land farming is a treatment of organic sludge, the sludge is spread on a piece of land and left to degrade. Sometimes plants are grown on the land, but those plants are destroyed.	Output	Residue	Waste in land farming	1.66E+01			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from incineration plant.	Output	Residue	Waste to incineration	2.79E+00			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www.energieforschung.ch. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their life cycles. The results can be used in life cycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans. Vattenfalls purpose - as a commissioner of putting ETH:s data into Spine format with metadata - is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines. Data is supposed to be used together with IEA statistics about electricity generation mixes in the OECD

	countries/regions.
Detailed Purpose	ETH:s aim was to describe the average situation in the UCPTE concerning electricity generation with stone coal. With the help of assumptions and simplifications following phases of the life cycle are described: mining (open pit and underground)), processing, transports, storage and power plant.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Data reported here is supposed to be representative for stone coal based electricity generation in the UCPTE countries in 1994. Figures for the cokery included in the study are representative for Germany, European cokeries probably have larger emissions. This set of data is aggregated and documented in accordance with the Swedish EPD-guidelines to be used in combination with IEA statistics concerning electricity generation mixes in OECD countries and regions together with other datasets - based on the ETH study - describing other power generation systems. The EPD-adapted power generation systems in Spine format are named as follows: Fuel gas electricity energy system, EPD-version Biofuel electricity energy system, EPD-version Hydro electricity energy system, EPD-version Lignite electricity energy system, EPD-version Nuclear electricity energy system, EPD-version Stone coal electricity energy system, EPD-version Wind electricity energy system, EPD-version IEA statistics for generation mixes 1998 exist in Spine format for the following 30 countries/regions: OECD total OECD North America OECD Pacific OECD Europe European Union Australia Austria Belgium Canada Czech Rpublic Denmark Finland France Germany Greece Hungary Iceland Ireland Italy Japan Korea Luxembourg Mexico Netherlands New Zealand Norway Poland Portugal Spain Sweden Switzerland Turkey United Kingdom United States
About Data	Most data concerning coal power are based on assumptions and estimates. Emissions of CO2, SO2, NOx, particulates and heat are quite reliable however. Since 45% of coal used in UCPTE power plants is imported and mines in the exporting regions often are supplied with fossil electricity, data does probablynot match with realemissions from electricity generation (underestimation of fossil pollutants, overestimation of radionuclide emissions and nuclear waste generation). Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided). Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of ETH:s data and metadata has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of aggregation of figures and of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data

	documentation requirements. The technical committee of the Swedish Environmental Management Council - approval of method and aggregation of parameters Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut -- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 6 June 2001: <<< Changes made by Ann-Christin Pålsson, CPM based on discussions with Caroline Setterwall, Vattenfall AB. Comments: The following changes has been made in the nomenclature for in- and outflows: Mangane in ore -> changed to: Manganese in ore CH4 -> changed to: Methane (to be in accordance with the nomenclature specified in CPM report 2000:2) CN -> changed to: CN- Stone coal -> changed to: Hard coal (to be in accordance with the nomenclature specified in CPM report 2000:2) Other metals -> changed to: Metals Explanations of nomenclature (inserted in Notes for the specific flows): - CN- is Cyanide ion - Reactive waste deposit is waste at landfill that is still reactive. - Inert waste deposit is waste at landfill that are inert. Additional clarifications: - Note that the flows of waste in the table of in- and outflows are internal flows, i.e. they do NOT cross the system boundaries. All waste handling processes is included in the study with respect to use of resources and emissions. - Radioactive waste is accounted for in cubic metres. The product specific requirements for electricity and district heating generation (PSR 1998:1) in the Swedish EPD system states that waste shall be accounted for in gram. However, no conversion factors were given in the study. There are also no general conversion factors that are commonly used.

SPINE LCI dataset: Stone coal electricity energy system, ETH - full version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Stone coal electricity energy system, ETH - full version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	UCTPE countries Europe
Sector	Grid electricity and district heat
Owner	UCTPE countries Europe
Technical system description	Reported figures come from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996. Brief description

The main phases inventoried in ETH's life cycle study of electricity generation with stone coal are: mining of coal (open pit and underground), processing I, processing II, transports, storage, power plant operation.
Data has been aquired from literature and figures concerning consumption of energyware and materials, use of land and water, emissions to air (also radioactive) and water and wastes have been picked out from or calculated based on literature for all phases of the life cycle.
All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources, waste handling and emissions is included for the manufacturing of main materials and energyware used in the lifecycle.

Detailed description

Mining and processing I
The prospecting of coal implies test drillings etc but is not inventoried separatly since only a few millimeters of drilling per tonne coal is needed.
Production of explosives used is included. Radioactive radon, methane and particles are process specific emissions to air and subsoilwater to water.

Open pit mining (28% of used stone coal in UCPTE) is used when the coal is found at a depth of a few to 500 meters. The subsoil water level must be lowered below the seam. Mainly diesel driven mobile machines are used. Underground mining (72% of used stone coal in UCPTE) involves the construction of shafts and galleries and the use of mainly electric hoists etc. Typical coal depths are 100-1200 meters. Emitted methane is partly used as fuel. Air condition and cooling plants are included.

The average loss of extracted coal in the mechanic processing plant is assumed to be 30% of the weight for open pit mines and 40% of the weight for underground mines. The assumed average energetic loss however is 5% and 8% respectively. The advantages of processing is for example higher heating value, lower sulphur content, less transports and better furnace conditions. All stone coal is supposed to be processed in this study.

Construction and operation of mines and processing plants are inventoried. Demolition processes are assumed to be neglectable, transports and deposit areas are however included.

Processing II
Most of the coal used in power plants in the UCPTE is steam coal coming directly from the first processing plant but in Germany also coke is used (about 18 % of the use in UCPTE). In the cokery coal is degassed in four steps at increasing temperatures. The products are several, coke typically 79% by weight. The cokery is assumed to be supplied with coke gas. Construction phase and area use has been estimated.

Transports and storage
Transports of stone coal from 6 supply regions have been inventoried regarding distances, vehicles and transshipment. Coal losses and emissions of particles (relatively large) during transport have been estimated. Coal storages are included, their emissions to air and leaching water (rough figures). Coal storages emit CO2 due to oxidation of coal, these emission are assumed to happen in the power plant in the ETH calculations. Construction and scrapping of vehicles are included.

Power plant
Construction and area use has been inventoried for two standard plants (100 and 500 MWe). The smaller standard plant is equiped with electrofilter and wet desulphuring with lime or limestone, the larger plant has a SCR de-NOx device as well. 90% of the UCPTE stone coal power plants are assumed to belong to the 500 MWe class. The plants are medium load power plants with an average of 4000 h of operation per year. Furnace technology is conventional (i.e. no gasifyers or fluid beds). Average efficiencies of power plants have been calculated (35.7%) based on national statistics. Incoming coal to the UCPTE power plants (average heating value 25,1 MJ/kg) is mixed, grinded and dried. Furnace temperatures of 1,300°C giving fly ashes or 1,600°C leading to ash melting are used. Concerning conventional emissions to air national statistics and bottom-up calculations based on existing UCPTE power plants have been used. Emissions of trace elements are estimated and other emissions are calculated based on literature data. Oil-fuelled starting plant is included. Leaching of substances from deposited ashes is included.

* Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries

Nature Boundary

Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included).

Land is divided into two main groups - land and sea - which are subdivided into 4 categories each.

Land Criterion Category
Natural human impact not larger than other species' since the industrial revolution I
Modified human impact larger than other species', low degree of cultivation II
Cultivated human impact larger than other species', large degree of cultivation III
Built upon dominated by buildings, roads, dams, mines etc. IV

Category I is not used in the study.

State of land before, during and after exploitation is of interest. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a

	higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. They express use of land in the unit m2year which is different from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH's LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH.
Time Boundary	Most background data refer to the period 1990 to 1994. Concerning flue gas cleaning equipment data from 1995/96 has been used where possible. Figures regarding use of materials and mining and processing of coal are older which probably doesn´t affect the result much. Future emissions from deposits for filter ashes are included. The amounts of imported coal to the UCPTE are based on the year 1993. Power plant operation is based on the year 1994. Electricity used during the lifecycle has been assumed to be a mix based on the average generation in the UCPTE* countries between 1990-94 (to level off the large variations in hydro power production over the years). All processes, also those conducted in the past, have been assumed to use average technology of the early nineties. Different technical lifetimes/reference times for different parts and materials of the studied systems have been used as follows: Equipment in mines 30 years Cokery 30 years Power plant 40 years * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Geographical Boundary	Figures are based on average stone coal power plants in Austria, Belgium, Spain, Italy, Ex-Jugoslavia, France, Netherlands, Portugal, and Germany. The emphasis concerning the inventory of coal mining is the UCPTE but also North and South America, South Africa, Australia&The Far East and Eastern Europe have been regarded since those regions export hard coal to the UCPTE. About 45% of stone coal used in UCPTE power plants is imported from those other regions. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of ressources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	Data concerning material and energyware use in the construction phase of the mine are rough estimates based on a few real mines. Process specific (i.e. not energyware related) emissions to air from mines have not been included except for radon, methane and particles. The flow of substances in subsoil water is not complete and emissions due to leaching from heaps are rough estimates which probably has an influence on the results. Use and emissions of lubricating and hydraulic oil is not included. Emissions of N2O, dioxines and radioactive substances from cokeries are not included (emissions of other greenhouse gases, hydrocarbons (also aromatic), heavy metals and inorganic substances are included). No accidents were considered in the cokery. Emissions of heavy metals found in emitted particles during transport of coal has not been considered. Emissions of benzene, toluol and xylol from long-time coal storages are not included (emissions of heavy metals and hydrocarbons to water are however included). Accidents are not considered in the power plant. Most data concerning the power plant are based on assumptions and estimates. Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more thorough calculations in ETH:s LCA for coal power. Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	Allocation in the cokery between the products have been studied according to energy content, weight and price. The results gave an allocation of 76-83% on the coke. In the ETH study 80% has been allocated to coke. The cutoff-method has been used for material use, i.e. 100% of the environmental load for

	virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Average electricity generation with stone coal in the UCTPE countries.
Method	The figures have been copied from the module ''Electricity stone coal power plant UCPTE'' (Strom ab Steinkohlekraftwerk UCPTE-Mix) in the Ökoinventare von Energiesystemen, ETH Zürich 1996.
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	Multiple flows are reported for several emissions to air. This is because that in the original study emissions to air have been reported in three categories, indicated by one of the letters below following the substance name. - m = mobile (emissions from vehicles) - p = process (process specific emissions as for instance methane emissions during coal mining) - s = stationary (emissions from stationary combustion plants) This categorisation has however not been documented in this specification in the SPINE format.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Area II-III	1330			m2a	Ground	
	Input	Natural resource	Area III-IV	214			m2a	Ground	
	Input	Natural resource	Area II-IV	434			m2a	Ground	
	Input	Natural resource	Area IV-IV	0.489			m2a	Ground	
	Input	Natural resource	Area, sea bed II-III	190			m2a	Ground	
	Input	Natural resource	Area, sea bed II-IV	19.6			m2a	Ground	
	Input	Natural resource	Barite	12			kg	Ground	
	Input	Natural resource	Bauxite	17.8			kg	Ground	
	Input	Natural resource	Bentonite	10.5			kg	Ground	
	Input	Natural resource	Chromium in ore	1.09			kg	Ground	
	Input	Natural resource	Clay	73.9			kg	Ground	
	Input	Natural resource	Copper in ore	4.28			kg	Ground	
	Input	Natural resource	Crude oil	2.58			tonne	Ground	
	Input	Natural resource	Gravel	2920			kg	Ground	
	Input	Natural resource	Hydro energy	0.00883			TJ	Water	
	Input	Natural resource	Iron in ore	856			kg	Ground	
	Input	Natural resource	Lead in ore	0.25			kg	Ground	
	Input	Natural resource	Lignite	1950			kg	Ground	
	Input	Natural resource	Limestone	2210			kg	Ground	
	Input	Natural resource	Manganese in ore	0.783			kg	Ground	
	Input	Natural resource	Mine gas (methane)	1210			kg	Ground	
	Input	Natural resource	Natural gas	177			Nm3	Ground	
	Input	Natural resource	Natural gas	450			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.377			kg	Ground	

	Input	Natural resource	Palladium in ore	0.00000047			kg	Ground	
	Input	Natural resource	Platinum in ore	0.000000539			kg	Ground	
	Input	Natural resource	Rhodium in ore	0.000000501			kg	Ground	
	Input	Natural resource	Rock salt	52.4			kg	Ground	
	Input	Natural resource	Sand	19.2			kg	Ground	
	Input	Natural resource	Stone coal	183000			kg	Ground	
	Input	Natural resource	Turbine water amount	46400			m3	Water	
	Input	Natural resource	Uranium in ore	0.133			kg	Ground	
	Input	Natural resource	Water	10700000			kg	Ground	
	Input	Natural resource	Wood	1.32			tonne	Ground	
	Input	Natural resource	Working amount in water storages	192			m3a	Water	
	Input	Natural resource	Zinc in ore	0.0396			kg	Ground	
	Input	Refined resource	Cobalt	0.00000244			kg	Technosphere	
	Input	Refined resource	Molybdenum	0.00000122			kg	Technosphere	
	Input	Refined resource	Rhenium	0.000000464			kg	Technosphere	
	Input	Refined resource	Silver	0.00812			kg	Technosphere	
	Input	Refined resource	Tin	0.00451			kg	Technosphere	
	Output	Emission	1,1,1-Trichloroethane	0.000000244			kg	Fresh water	
	Output	Emission	1,2-Dichloroethane	0.0000401			kg	Fresh water	
	Output	Emission	1,2-Dichloroethane	0.000078			kg	Air	
	Output	Emission	Acenaphthylene	0.000532			kg	Fresh water	
	Output	Emission	Acetaldehyde	0.00334			kg	Air	
	Output	Emission	Acetic acid	0.0148			kg	Air	
	Output	Emission	Acetone	0.00326			kg	Air	
	Output	Emission	Acetylene	0.00561			kg	Air	
	Output	Emission	Acids	0.00322			kg	Fresh water	
	Output	Emission	Acroleine	0.000000813			kg	Air	
	Output	Emission	Ag	0.0000652			kg	Fresh water	
	Output	Emission	Ag	0.0000689			kg	Sea water	
	Output	Emission	Ag-110m	0.0000548			kBq	Air	
	Output	Emission	Ag-110m	0.374			kBq	Fresh water	
	Output	Emission	Al	0.00019			kg	Sea water	
	Output	Emission	Al	0.00541			kg	Air	
	Output	Emission	Al	0.00829			kg	Air	
	Output	Emission	Al	0.157			kg	Ground	
	Output	Emission	Al	292			kg	Fresh water	
	Output	Emission	Al	9.42			kg	Air	
	Output	Emission	Aldehydes	0.000106			kg	Air	
	Output	Emission	Alkanes	0.00194			kg	Fresh water	
	Output	Emission	Alkanes	0.0149			kg	Sea water	
	Output	Emission	Alkanes	0.0514			kg	Air	
	Output	Emission	Alkanes	0.643			kg	Air	
	Output	Emission	Alkenes	0.00011			kg	Air	
	Output	Emission	Alkenes	0.000179			kg	Fresh water	
	Output	Emission	Alkenes	0.00138			kg	Sea water	
	Output	Emission	Alkenes	0.622			kg	Air	
	Output	Emission	Alpha radiator	0.0000443			kBq	Fresh water	
	Output	Emission	Am-241	0.00102			kBq	Air	
	Output	Emission	Am-241	0.135			kBq	Sea water	
	Output	Emission	AOX	0.000177			kg	Sea water	
	Output	Emission	AOX	0.000309			kg	Fresh water	
	Output	Emission	Ar-41	119			kBq	Air	
	Output	Emission	Aromates	0.000011			kg	Air	
	Output	Emission	Aromates	0.00168			kg	Air	
	Output	Emission	Aromatics	0.00778			kg	Fresh water	
	Output	Emission	Aromatics	0.0702			kg	Sea water	
	Output	Emission	As	0.0000426			kg	Sea water	
	Output	Emission	As	0.0000629			kg	Ground	
	Output	Emission	As	0.000139			kg	Air	
	Output	Emission	As	0.000829			kg	Air	

	Output	Emission	As	0.0212			kg	Air	
	Output	Emission	As	0.59			kg	Fresh water	
	Output	Emission	B	0.0000137			kg	Air	
	Output	Emission	B	0.00173			kg	Sea water	
	Output	Emission	B	0.452			kg	Fresh water	
	Output	Emission	B	0.86			kg	Air	
	Output	Emission	Ba	0.0000502			kg	Air	
	Output	Emission	Ba	0.118			kg	Air	
	Output	Emission	Ba	0.287			kg	Sea water	
	Output	Emission	Ba	23.4			kg	Fresh water	
	Output	Emission	Ba-140	0.000216			kBq	Air	
	Output	Emission	Ba-140	0.000711			kBq	Fresh water	
	Output	Emission	Barite	2.37			kg	Sea water	
	Output	Emission	Be	0.000000605			kg	Air	
	Output	Emission	Be	0.000158			kg	Fresh water	
	Output	Emission	Be	0.00131			kg	Air	
	Output	Emission	Benzaldehyde	0.000000424			kg	Air	
	Output	Emission	Benzene	0.00043			kg	Air	
	Output	Emission	Benzene	0.00214			kg	Fresh water	
	Output	Emission	Benzene	0.0138			kg	Air	
	Output	Emission	Benzene	0.0149			kg	Sea water	
	Output	Emission	Benzene	0.0265			kg	Air	
	Output	Emission	Benzo(a)pyrene	0.00000131			kg	Air	
	Output	Emission	Benzo(a)pyrene	0.0000845			kg	Air	
	Output	Emission	BOD	0.00266			kg	Sea water	
	Output	Emission	BOD	0.128			kg	Fresh water	
	Output	Emission	Br	0.0000406			kg	Air	
	Output	Emission	Br	0.531			kg	Air	
	Output	Emission	Butane	0.067			kg	Air	
	Output	Emission	Butane	0.202			kg	Air	
	Output	Emission	Butene	0.00996			kg	Air	
	Output	Emission	C	0.487			kg	Ground	
	Output	Emission	C-14	6.81			kBq	Sea water	
	Output	Emission	C-14	82.4			kBq	Air	
	Output	Emission	Ca	0.00718			kg	Air	
	Output	Emission	Ca	0.0322			kg	Air	
	Output	Emission	Ca	0.629			kg	Ground	
	Output	Emission	Ca	2.32			kg	Air	
	Output	Emission	Ca	254			kg	Fresh water	
	Output	Emission	Ca	3.7			kg	Sea water	
	Output	Emission	Cd	0.00000276			kg	Air	
	Output	Emission	Cd	0.00000395			kg	Ground	
	Output	Emission	Cd	0.0000736			kg	Sea water	
	Output	Emission	Cd	0.000302			kg	Air	
	Output	Emission	Cd	0.00149			kg	Air	
	Output	Emission	Cd	0.0157			kg	Fresh water	
	Output	Emission	Cd-109	0.00000411			kBq	Fresh water	
	Output	Emission	Ce-141	0.00000509			kBq	Air	
	Output	Emission	Ce-141	0.000106			kBq	Fresh water	
	Output	Emission	Ce-144	0.0000303			kBq	Fresh water	
	Output	Emission	Ce-144	0.0109			kBq	Air	
	Output	Emission	Ce-144	3.08			kBq	Sea water	
	Output	Emission	CFC-11	0.0000421			kg	Air	
	Output	Emission	CFC-114	0.00111			kg	Air	
	Output	Emission	CFC-12	0.00000905			kg	Air	
	Output	Emission	CFC-13	0.00000568			kg	Air	
	Output	Emission	CH4	0.265			kg	Air	
	Output	Emission	CH4	1000			kg	Air	
	Output	Emission	CH4	3.24			kg	Air	
	Output	Emission	Chlorinated solvents	0.0000946			kg	Fresh water	
	Output	Emission	Chlorobenzenes	1.53E-09			kg	Fresh water	
	Output	Emission	Cl-	1800			kg	Fresh water	
	Output	Emission	Cl-	59.2			kg	Sea water	
	Output	Emission	ClO-	0.00422			kg	Sea water	
	Output	Emission	ClO-	0.998			kg	Fresh water	
	Output	Emission	Cm alpha	0.00162			kBq	Air	
	Output	Emission	Cm alpha	0.178			kBq	Sea water	
	Output	Emission	Cm-242	5.38E-09			kBq	Air	
	Output	Emission	Cm-244	4.89E-08			kBq	Air	
	Output	Emission	CN	0.000251			kg	Air	
	Output	Emission	CN	1.79E-11			kg	Air	
	Output	Emission	CN-	0.00019			kg	Sea water	
	Output	Emission	CN-	0.00397			kg	Fresh water	

	Output	Emission	Co	0.00000351			kg	Ground	
	Output	Emission	Co	0.0000774			kg	Air	
	Output	Emission	Co	0.000525			kg	Air	
	Output	Emission	Co	0.00804			kg	Air	
	Output	Emission	Co	0.584			kg	Fresh water	
	Output	Emission	CO	11.8			kg	Air	
	Output	Emission	CO	35.7			kg	Air	
	Output	Emission	CO	9.1			kg	Air	
	Output	Emission	CO2	272000			kg	Air	
	Output	Emission	CO2	4500			kg	Air	
	Output	Emission	CO2	-667			kg	Air	
	Output	Emission	Co-57	0.000000094			kBq	Air	
	Output	Emission	Co-57	0.000729			kBq	Fresh water	
	Output	Emission	Co-58	0.00156			kBq	Air	
	Output	Emission	Co-58	0.597			kBq	Fresh water	
	Output	Emission	Co-60	0.00232			kBq	Air	
	Output	Emission	Co-60	0.626			kBq	Fresh water	
	Output	Emission	Co-60	29.2			kBq	Sea water	
	Output	Emission	COD	0.0799			kg	Sea water	
	Output	Emission	COD	1.1			kg	Fresh water	
	Output	Emission	Cr	0.000414			kg	Air	
	Output	Emission	Cr	0.000787			kg	Ground	
	Output	Emission	Cr	0.000897			kg	Air	
	Output	Emission	Cr	0.0318			kg	Air	
	Output	Emission	Cr(VI)	0.000626			kg	Fresh water	
	Output	Emission	Cr3+	0.00102			kg	Sea water	
	Output	Emission	Cr3+	2.92			kg	Fresh water	
	Output	Emission	Cr-51	0.000193			kBq	Air	
	Output	Emission	Cr-51	0.0156			kBq	Fresh water	
	Output	Emission	Cs	0.0000625			kg	Fresh water	
	Output	Emission	Cs	0.000115			kg	Sea water	
	Output	Emission	Cs-134	0.0388			kBq	Air	
	Output	Emission	Cs-134	0.0777			kBq	Fresh water	
	Output	Emission	Cs-134	6.81			kBq	Sea water	
	Output	Emission	Cs-136	0.00000381			kBq	Fresh water	
	Output	Emission	Cs-137	0.075			kBq	Air	
	Output	Emission	Cs-137	0.178			kBq	Fresh water	
	Output	Emission	Cs-137	63.3			kBq	Sea water	
	Output	Emission	Cu	0.0000176			kg	Ground	
	Output	Emission	Cu	0.000266			kg	Sea water	
	Output	Emission	Cu	0.000411			kg	Air	
	Output	Emission	Cu	0.0267			kg	Air	
	Output	Emission	Cu	0.042			kg	Air	
	Output	Emission	Cu	1.47			kg	Fresh water	
	Output	Emission	Di-(2-ethylhexyl) phthalate	5.41E-09			kg	Fresh water	
	Output	Emission	Dibutyl p-phthalate	5.38E-08			kg	Fresh water	
	Output	Emission	Dichloromethane	0.000238			kg	Air	
	Output	Emission	Dichloromethane	0.00109			kg	Fresh water	
	Output	Emission	Different beta	0.00000717			kBq	Air	
	Output	Emission	Dimethyl p-phthalate	0.000000339			kg	Fresh water	
	Output	Emission	Dioxin (TCDD)	17000			ng	Air	
	Output	Emission	Dissolved organic carbon	0.0014			kg	Sea water	
	Output	Emission	Dissolved organic carbon	0.00525			kg	Fresh water	
	Output	Emission	Dissolved solids	11.3			kg	Sea water	
	Output	Emission	Dissolved solids	113			kg	Fresh water	
	Output	Emission	Ethane	0.128			kg	Air	
	Output	Emission	Ethane	0.136			kg	Air	
	Output	Emission	Ethanol	0.0000273			kg	Air	
	Output	Emission	Ethanol	0.00652			kg	Air	
	Output	Emission	Ethene	0.0431			kg	Air	
	Output	Emission	Ethene	0.18			kg	Air	
	Output	Emission	Ethylbenzene	0.000346			kg	Fresh water	
	Output	Emission	Ethylbenzene	0.00276			kg	Sea water	
	Output	Emission	Ethylbenzene	0.00469			kg	Air	
	Output	Emission	Ethylbenzene	0.616			kg	Air	
	Output	Emission	F-	0.00115			kg	Sea water	
	Output	Emission	F-	0.68			kg	Fresh water	
	Output	Emission	Fe	0.0136			kg	Sea water	
	Output	Emission	Fe	0.016			kg	Air	
	Output	Emission	Fe	0.0525			kg	Air	
	Output	Emission	Fe	0.315			kg	Ground	
	Output	Emission	Fe	4.84			kg	Air	
	Output	Emission	Fe	91.3			kg	Fresh water	

	Output	Emission	Fe-59	0.00000213			kBq	Air	
	Output	Emission	Fe-59	0.0000126			kBq	Fresh water	
	Output	Emission	Fission and rad. prod.	0.402			kBq	Fresh water	
	Output	Emission	Formaldehyde	0.00000637			kg	Fresh water	
	Output	Emission	Formaldehyde	0.0000696			kg	Air	
	Output	Emission	Formaldehyde	0.189			kg	Air	
	Output	Emission	Glutaraldehyde	0.000292			kg	Sea water	
	Output	Emission	H-1301	0.001			kg	Air	
	Output	Emission	H2S	0.00114			kg	Fresh water	
	Output	Emission	H2S	0.00687			kg	Air	
	Output	Emission	H2S	0.0455			kg	Air	
	Output	Emission	H-3	195000			kBq	Sea water	
	Output	Emission	H-3	7170			kBq	Fresh water	
	Output	Emission	H-3	847			kBq	Air	
	Output	Emission	HCFC-21	0.00181			kg	Air	
	Output	Emission	HCFC-22	0.00000992			kg	Air	
	Output	Emission	HCl	0.0341			kg	Air	
	Output	Emission	HCl	59.9			kg	Air	
	Output	Emission	He	0.0233			kg	Air	
	Output	Emission	He	0.155			kg	Air	
	Output	Emission	Heat	0.000163			TJ	Ground	
	Output	Emission	Heat	0.00138			TJ	Sea water	
	Output	Emission	Heat	0.0102			TJ	Air	
	Output	Emission	Heat	0.0665			TJ	Air	
	Output	Emission	Heat	0.366			TJ	Fresh water	
	Output	Emission	Heat	1.68			TJ	Air	
	Output	Emission	Heptane	0.0469			kg	Air	
	Output	Emission	Hexachlorobenzene	2.9E-09			kg	Air	
	Output	Emission	Hexachloroethane	8.92E-10			kg	Fresh water	
	Output	Emission	Hexafluoroethane	0.000193			kg	Air	
	Output	Emission	Hexane	0.0984			kg	Air	
	Output	Emission	HF	0.0091			kg	Air	
	Output	Emission	HF	10.3			kg	Air	
	Output	Emission	HFC-134a	9.95E-17			kg	Air	
	Output	Emission	Hg	0.000000596			kg	Ground	
	Output	Emission	Hg	0.000000689			kg	Sea water	
	Output	Emission	Hg	0.0000243			kg	Air	
	Output	Emission	Hg	0.0000812			kg	Air	
	Output	Emission	Hg	0.000374			kg	Fresh water	
	Output	Emission	Hg	0.0324			kg	Air	
	Output	Emission	HOCl	0.00422			kg	Sea water	
	Output	Emission	HOCl	0.998			kg	Fresh water	
	Output	Emission	Hydrocarbons	0.0013			kg	Fresh water	
	Output	Emission	I	0.0000322			kg	Air	
	Output	Emission	I	0.00144			kg	Fresh water	
	Output	Emission	I	0.0115			kg	Sea water	
	Output	Emission	I	0.117			kg	Air	
	Output	Emission	I-129	0.292			kBq	Air	
	Output	Emission	I-129	19.5			kBq	Sea water	
	Output	Emission	I-131	0.013			kBq	Fresh water	
	Output	Emission	I-131	0.033			kBq	Air	
	Output	Emission	I-133	0.00325			kBq	Fresh water	
	Output	Emission	I-133	0.0181			kBq	Air	
	Output	Emission	I-135	0.0271			kBq	Air	
	Output	Emission	K	0.147			kg	Air	
	Output	Emission	K	0.5			kg	Sea water	
	Output	Emission	K	1.21			kg	Air	
	Output	Emission	K	87.9			kg	Fresh water	
	Output	Emission	K-40	15.7			kBq	Air	
	Output	Emission	K-40	61.3			kBq	Fresh water	
	Output	Emission	Kr-85	5030000			kBq	Air	
	Output	Emission	Kr-85m	6.15			kBq	Air	
	Output	Emission	Kr-87	2.72			kBq	Air	
	Output	Emission	Kr-88	237			kBq	Air	
	Output	Emission	Kr-89	1.93			kBq	Air	
	Output	Emission	La	0.00000251			kg	Air	
	Output	Emission	La	0.0038			kg	Air	
	Output	Emission	La-140	0.000136			kBq	Air	
	Output	Emission	La-140	0.000147			kBq	Fresh water	
	Output	Emission	Methanol	0.0071			kg	Air	
	Output	Emission	Methyl Tertiary Butyl Ether	0.000000902			kg	Sea water	
	Output	Emission	Methyl Tertiary Butyl Ether	0.00000166			kg	Fresh water	
	Output	Emission	Methyl Tertiary Butyl Ether	0.0000268			kg	Air	

	Output	Emission	Mg	0.0038			kg	Air	
	Output	Emission	Mg	0.0759			kg	Sea water	
	Output	Emission	Mg	2.57			kg	Air	
	Output	Emission	Mg	244			kg	Fresh water	
	Output	Emission	Mn	0.00629			kg	Ground	
	Output	Emission	Mn	0.028			kg	Sea water	
	Output	Emission	Mn	0.0309			kg	Air	
	Output	Emission	Mn	0.0395			kg	Air	
	Output	Emission	Mn	5.96			kg	Fresh water	
	Output	Emission	Mn-54	0.0000557			kBq	Air	
	Output	Emission	Mn-54	0.0279			kBq	Fresh water	
	Output	Emission	Mn-54	4.54			kBq	Sea water	
	Output	Emission	Mo	0.000000746			kg	Air	
	Output	Emission	Mo	0.0000381			kg	Sea water	
	Output	Emission	Mo	0.000663			kg	Air	
	Output	Emission	Mo	0.00851			kg	Air	
	Output	Emission	Mo	0.826			kg	Fresh water	
	Output	Emission	Mo-99	0.0000497			kBq	Fresh water	
	Output	Emission	N	0.000171			kg	Ground	
	Output	Emission	N total	0.0666			kg	Sea water	
	Output	Emission	N total	0.27			kg	Fresh water	
	Output	Emission	N2	0.121			kg	Air	
	Output	Emission	N2O	0.0336			kg	Air	
	Output	Emission	N2O	0.228			kg	Air	
	Output	Emission	N2O	1.53			kg	Air	
	Output	Emission	Na	0.000251			kg	Air	
	Output	Emission	Na	0.0425			kg	Air	
	Output	Emission	Na	0.696			kg	Air	
	Output	Emission	Na	248			kg	Fresh water	
	Output	Emission	Na	35.7			kg	Sea water	
	Output	Emission	Na-24	0.0219			kBq	Fresh water	
	Output	Emission	Nb-95	0.00000984			kBq	Air	
	Output	Emission	Nb-95	0.000403			kBq	Fresh water	
	Output	Emission	NH3	0.00737			kg	Air	
	Output	Emission	NH3	1.49			kg	Air	
	Output	Emission	NH4+ as N	0.0499			kg	Sea water	
	Output	Emission	NH4+ as N	0.304			kg	Fresh water	
	Output	Emission	Ni	0.0000263			kg	Ground	
	Output	Emission	Ni	0.000313			kg	Sea water	
	Output	Emission	Ni	0.00542			kg	Air	
	Output	Emission	Ni	0.0306			kg	Air	
	Output	Emission	Ni	0.0414			kg	Air	
	Output	Emission	Ni	1.47			kg	Fresh water	
	Output	Emission	NMVOC	2.73			kg	Air	
	Output	Emission	NMVOC	20.9			kg	Air	
	Output	Emission	NMVOC	3.08			kg	Air	
	Output	Emission	NO2-	0.0000321			kg	Fresh water	
	Output	Emission	NO2-	0.00519			kg	Sea water	
	Output	Emission	NO3-	0.0312			kg	Sea water	
	Output	Emission	NO3-	5.35			kg	Fresh water	
	Output	Emission	Noble gases (radioactive)	7.51			kBq	Air	
	Output	Emission	NOx	2.5			kg	Air	
	Output	Emission	NOx	388			kg	Air	
	Output	Emission	NOx	61.2			kg	Air	
	Output	Emission	Np-237	0.0086			kBq	Sea water	
	Output	Emission	Np-237	5.35E-08			kBq	Air	
	Output	Emission	Nuclide mix	0.000292			kBq	Fresh water	
	Output	Emission	Oil	0.0209			kg	Ground	
	Output	Emission	Oil	0.0363			kg	Fresh water	
	Output	Emission	Oil	2.35			kg	Sea water	
	Output	Emission	Organic N	0.00857			kg	Sea water	
	Output	Emission	Organic N	0.0151			kg	Fresh water	
	Output	Emission	P	0.000037			kg	Air	
	Output	Emission	P	0.00486			kg	Air	
	Output	Emission	P	0.00822			kg	Ground	
	Output	Emission	P	0.129			kg	Air	
	Output	Emission	P	0.145			kg	Ground	
	Output	Emission	Pa-234m	0.0325			kBq	Air	
	Output	Emission	Pa-234m	0.601			kBq	Fresh water	
	Output	Emission	PAH	0.00000705			kg	Air	
	Output	Emission	PAH	0.000293			kg	Fresh water	
	Output	Emission	PAH	0.00149			kg	Sea water	
	Output	Emission	PAH	0.00343			kg	Air	

	Output	Emission	Particles	235			kg	Air	
	Output	Emission	Particles	3.59			kg	Air	
	Output	Emission	Particles	83			kg	Air	
	Output	Emission	Pb	0.0000608			kg	Sea water	
	Output	Emission	Pb	0.0000804			kg	Ground	
	Output	Emission	Pb	0.00196			kg	Air	
	Output	Emission	Pb	0.00284			kg	Air	
	Output	Emission	Pb	0.0611			kg	Air	
	Output	Emission	Pb	1.48			kg	Fresh water	
	Output	Emission	Pb-210	0.361			kBq	Air	
	Output	Emission	Pb-210	48.8			kBq	Fresh water	
	Output	Emission	Pb-210	54.9			kBq	Air	
	Output	Emission	Pentachlorobenzene	7.76E-09			kg	Air	
	Output	Emission	Pentachlorophenol	1.25E-09			kg	Air	
	Output	Emission	Pentane	0.248			kg	Air	
	Output	Emission	Pentane	0.436			kg	Air	
	Output	Emission	Phenol	0.000237			kg	Air	
	Output	Emission	Phenol	0.008			kg	Fresh water	
	Output	Emission	Phenol	0.0135			kg	Sea water	
	Output	Emission	Phosphoric compound	0.0000778			kg	Fresh water	
	Output	Emission	Pm-147	0.0276			kBq	Air	
	Output	Emission	Po-210	0.361			kBq	Air	
	Output	Emission	Po-210	100			kBq	Air	
	Output	Emission	Po-210	48.8			kBq	Fresh water	
	Output	Emission	PO43-	0.000381			kg	Sea water	
	Output	Emission	PO43-	17.5			kg	Fresh water	
	Output	Emission	Propane	0.118			kg	Air	
	Output	Emission	Propane	0.215			kg	Air	
	Output	Emission	Propene	0.0101			kg	Air	
	Output	Emission	Propene	0.0514			kg	Air	
	Output	Emission	Propionic acid	0.000231			kg	Air	
	Output	Emission	Propionic aldehyde	0.000000424			kg	Air	
	Output	Emission	Pt	0.00000104			kg	Air	
	Output	Emission	Pu alpha	0.00324			kBq	Air	
	Output	Emission	Pu alpha	0.535			kBq	Sea water	
	Output	Emission	Pu-238	0.000000122			kBq	Air	
	Output	Emission	Pu-241 beta	0.0892			kBq	Air	
	Output	Emission	Pu-241 beta	13.3			kBq	Sea water	
	Output	Emission	Ra-224	0.718			kBq	Fresh water	
	Output	Emission	Ra-224	5.74			kBq	Sea water	
	Output	Emission	Ra-226	1.02			kBq	Air	
	Output	Emission	Ra-226	11.5			kBq	Sea water	
	Output	Emission	Ra-226	14.2			kBq	Air	
	Output	Emission	Ra-226	2510			kBq	Fresh water	
	Output	Emission	Ra-228	1.44			kBq	Fresh water	
	Output	Emission	Ra-228	11.5			kBq	Sea water	
	Output	Emission	Ra-228	7.68			kBq	Air	
	Output	Emission	Rb	0.000558			kg	Fresh water	
	Output	Emission	Rb	0.00115			kg	Sea water	
	Output	Emission	Rn-220	651			kBq	Air	
	Output	Emission	Rn-222	1170			kBq	Air	
	Output	Emission	Rn-222	79900			kBq	Air	
	Output	Emission	Rn-222 (long term)	7220000			kBq	Air	
	Output	Emission	Ru-103	0.000000559			kBq	Air	
	Output	Emission	Ru-103	0.000238			kBq	Fresh water	
	Output	Emission	Ru-106	0.324			kBq	Air	
	Output	Emission	Ru-106	32.4			kBq	Sea water	
	Output	Emission	S	0.0945			kg	Ground	
	Output	Emission	S2-	0.00152			kg	Sea water	
	Output	Emission	S2-	0.00276			kg	Fresh water	
	Output	Emission	Salt	9.56			kg	Fresh water	
	Output	Emission	Sb	0.000000274			kg	Air	
	Output	Emission	Sb	0.00255			kg	Air	
	Output	Emission	Sb	0.0048			kg	Fresh water	
	Output	Emission	Sb-122	0.000711			kBq	Fresh water	
	Output	Emission	Sb-124	0.0000151			kBq	Air	
	Output	Emission	Sb-124	0.0968			kBq	Fresh water	
	Output	Emission	Sb-125	0.00000197			kBq	Air	
	Output	Emission	Sb-125	0.0058			kBq	Fresh water	
	Output	Emission	Sc	0.00000099			kg	Air	
	Output	Emission	Sc	0.00162			kg	Air	
	Output	Emission	Se	0.0000607			kg	Sea water	
	Output	Emission	Se	0.000243			kg	Air	

	Output	Emission	Se	0.00238			kg	Air	
	Output	Emission	Se	0.0402			kg	Air	
	Output	Emission	Se	1.46			kg	Fresh water	
	Output	Emission	Si	0.00624			kg	Air	
	Output	Emission	Si	0.00718			kg	Air	
	Output	Emission	Si	0.102			kg	Fresh water	
	Output	Emission	Si	16.7			kg	Air	
	Output	Emission	Sn	0.000000502			kg	Air	
	Output	Emission	Sn	0.00312			kg	Fresh water	
	Output	Emission	Sn	0.00313			kg	Air	
	Output	Emission	SO2	4.47			kg	Air	
	Output	Emission	SO2	89.6			kg	Air	
	Output	Emission	SO2	968			kg	Air	
	Output	Emission	SO32-	0.105			kg	Fresh water	
	Output	Emission	SO42-	1280			kg	Fresh water	
	Output	Emission	SO42-	5.24			kg	Sea water	
	Output	Emission	Sr	0.0000502			kg	Air	
	Output	Emission	Sr	0.12			kg	Air	
	Output	Emission	Sr	0.691			kg	Sea water	
	Output	Emission	Sr	3.58			kg	Fresh water	
	Output	Emission	Sr-89	0.0000973			kBq	Air	
	Output	Emission	Sr-89	0.00161			kBq	Fresh water	
	Output	Emission	Sr-90	0.000593			kBq	Fresh water	
	Output	Emission	Sr-90	0.0536			kBq	Air	
	Output	Emission	Sr-90	6.49			kBq	Sea water	
	Output	Emission	Suspended solids	2.33			kg	Fresh water	
	Output	Emission	Suspended solids	8.44			kg	Sea water	
	Output	Emission	Tc-99	0.00000227			kBq	Air	
	Output	Emission	Tc-99	3.41			kBq	Sea water	
	Output	Emission	Tc-99m	0.000335			kBq	Fresh water	
	Output	Emission	Te-123	0.00003			kBq	Fresh water	
	Output	Emission	Te-123m	0.000245			kBq	Air	
	Output	Emission	Te-132	0.0000123			kBq	Fresh water	
	Output	Emission	Tetrachloroethene	0.000000106			kg	Fresh water	
	Output	Emission	Tetrachloromethane	0.000000162			kg	Fresh water	
	Output	Emission	Tetrachloromethane	0.0000578			kg	Air	
	Output	Emission	Tetrafluoromethane	0.00174			kg	Air	
	Output	Emission	Th	0.00000099			kg	Air	
	Output	Emission	Th	0.0028			kg	Air	
	Output	Emission	Th-228	2.87			kBq	Fresh water	
	Output	Emission	Th-228	23			kBq	Sea water	
	Output	Emission	Th-228	6.5			kBq	Air	
	Output	Emission	Th-230	0.361			kBq	Air	
	Output	Emission	Th-230	94			kBq	Fresh water	
	Output	Emission	Th-232	11.4			kBq	Fresh water	
	Output	Emission	Th-232	4.13			kBq	Air	
	Output	Emission	Th-234	0.0325			kBq	Air	
	Output	Emission	Th-234	0.607			kBq	Fresh water	
	Output	Emission	Ti	0.000152			kg	Air	
	Output	Emission	Ti	0.492			kg	Air	
	Output	Emission	Ti	17.5			kg	Fresh water	
	Output	Emission	Tl	0.000000251			kg	Air	
	Output	Emission	Tl	0.00134			kg	Air	
	Output	Emission	Toluene	0.0017			kg	Fresh water	
	Output	Emission	Toluene	0.0124			kg	Sea water	
	Output	Emission	Toluene	0.031			kg	Air	
	Output	Emission	Toluene	0.314			kg	Air	
	Output	Emission	Total organic carbon	0.0701			kg	Fresh water	
	Output	Emission	Total organic carbon	0.585			kg	Sea water	
	Output	Emission	Total organic carbon	0.788			kg	Sea water	
	Output	Emission	Total organic carbon	4.3			kg	Fresh water	
	Output	Emission	Tributyltin	0.00554			kg	Sea water	
	Output	Emission	Trichloroethene	0.00000669			kg	Fresh water	
	Output	Emission	Trichloromethane	0.00000206			kg	Air	
	Output	Emission	Trichloromethane	0.0000245			kg	Fresh water	
	Output	Emission	Triethylene glycol	0.0014			kg	Sea water	
	Output	Emission	Triethylene glycol	0.00525			kg	Fresh water	
	Output	Emission	U	0.000000502			kg	Air	
	Output	Emission	U	0.0032			kg	Air	
	Output	Emission	U alpha	0.112			kBq	Sea water	
	Output	Emission	U alpha	1.16			kBq	Air	
	Output	Emission	U alpha	39.2			kBq	Fresh water	
	Output	Emission	U-234	0.389			kBq	Air	

	Output	Emission	U-234	0.804			kBq	Fresh water	
	Output	Emission	U-235	0.0189			kBq	Air	
	Output	Emission	U-235	1.2			kBq	Fresh water	
	Output	Emission	U-238	0.384			kBq	Air	
	Output	Emission	U-238	11.8			kBq	Air	
	Output	Emission	U-238	25.7			kBq	Fresh water	
	Output	Emission	V	0.0000381			kg	Sea water	
	Output	Emission	V	0.000114			kg	Air	
	Output	Emission	V	0.0757			kg	Air	
	Output	Emission	V	0.11			kg	Air	
	Output	Emission	V	1.47			kg	Fresh water	
	Output	Emission	W	0.0145			kg	Fresh water	
	Output	Emission	Vinyl chloride	0.0000127			kg	Air	
	Output	Emission	Vinyl chloride	3.01E-08			kg	Fresh water	
	Output	Emission	VOC	0.00503			kg	Fresh water	
	Output	Emission	VOC	0.0402			kg	Sea water	
	Output	Emission	Xe-121m	12.5			kBq	Air	
	Output	Emission	Xe-133	3610			kBq	Air	
	Output	Emission	Xe-133m	1.81			kBq	Air	
	Output	Emission	Xe-135	619			kBq	Air	
	Output	Emission	Xe-135m	62.7			kBq	Air	
	Output	Emission	Xe-137	1.55			kBq	Air	
	Output	Emission	Xe-138	17			kBq	Air	
	Output	Emission	Xylene	0.00143			kg	Fresh water	
	Output	Emission	Xylene	0.0108			kg	Sea water	
	Output	Emission	Xylol	0.0471			kg	Air	
	Output	Emission	Xylol	2.62			kg	Air	
	Output	Emission	Y-90	0.0000821			kBq	Fresh water	
	Output	Emission	Zn	0.000403			kg	Sea water	
	Output	Emission	Zn	0.00254			kg	Ground	
	Output	Emission	Zn	0.00761			kg	Air	
	Output	Emission	Zn	0.0158			kg	Air	
	Output	Emission	Zn	0.0898			kg	Air	
	Output	Emission	Zn	2.96			kg	Fresh water	
	Output	Emission	Zn-65	0.00024			kBq	Air	
	Output	Emission	Zn-65	0.0462			kBq	Fresh water	
	Output	Emission	Zr	0.0000122			kg	Air	
	Output	Emission	Zr-95	0.00000356			kBq	Air	
	Output	Emission	Zr-95	0.0000981			kBq	Fresh water	
	Output	Emission	Zr-95	0.276			kBq	Sea water	
	Output	Product	Electricity	1			TJ	Technosphere	
	Output	Residue	Hazardous waste	24.5			kg	Technosphere	
	Output	Residue	Highly radioactive waste	0.000659			kg	Technosphere	
	Output	Residue	Inert waste deposit	60500			kg	Technosphere	
	Output	Residue	Low radioactive waste	0.0000227			kg	Technosphere	
	Output	Residue	Medium and low radioactive waste	0.000278			kg	Technosphere	
	Output	Residue	Reactive waste deposit	19			kg	Technosphere	
	Output	Residue	Waste deposit	5250			kg	Technosphere	
	Output	Residue	Waste in land farming	16.6			kg	Technosphere	
	Output	Residue	Waste to incineration	2.79			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www.energieforschung.ch. --- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden ---
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their life cycles. The results can be used in life cycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans.
Detailed Purpose	ETH:s aim was to describe the average situation in the UCPTE concerning electricity generation with stone coal. With the help of assumptions and simplifications following phases of the life cycle are described: mining (open pit and underground)), processing, transports, storage and power plant.

Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Data reported here is supposed to be representative for stone coal based electricity generation in the UCPTE countries in 1994. Figures for the cokery included in the study are representative for Germany, European cokeries probably have larger emissions.
About Data	Most data concerning coal power are based on assumptions and estimates. Emissions of CO2, SO2, NOx, particulates and heat are quite reliable however. Since 45% of coal used in UCPTE power plants is imported and mines in the exporting regions often are supplied with fossil electricity, data does probablynot match with realemissions from electricity generation (underestimation of fossil pollutants, overestimation of radionuclide emissions and nuclear waste generation). Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided). Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of metadata describing the ETH study has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut

SPINE LCI dataset: Storage and distribution of chemicals and intermediate storage of hazardous waste.

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Storage and distribution of chemicals and intermediate storage of hazardous waste.
Functional Unit	1996
Functional Unit Explanation	The extent of the production is not mentioned in the Environmental report. Because of this we have no functional unit which makes it impossible to use the data direct for life cycle analysis. Though, it is possible to get in touch with the company and try to get some more information.
Process Type	Gate to gate
Site	Stena Miljö AB Salsmästaregatan 21 422 46 Göteborg Sweden
Sector	Waste sorting and collection
Owner	Stena Miljö AB Salsmästaregatan 21 422 46 Göteborg Sweden

Technical system description	Storage and distribution of photo chemicals and intermediate storage of waste that is hazardous to the environment from graphic and photographic activities.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	Average electricity generation with stone coal in the UCTPE countries.
Method	Study the environmental report from Stena Miljö AB for 1996. The amounts in the table are taken directly from the environmental report, and shows the resourses, residues and emissions for the annual production of 1996.
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	The data represents a total amount for 1996.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1996 Data type: Unspecified Notes: Hasardous for the environment	Input	Refined resource	Bleach fixing-bath	161			m3	Technosphere	
Notes: Hasardous for the environment	Input	Refined resource	Developing-bath	907			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Hasardous for the environment	Input	Refined resource	Fixing-bath	524			m3	Technosphere	
Notes: Hazardous waste (ion exchanging mass, containing antimony, arsenic, barium, beryllium, led, cobalt, cupper, chromium, nickel, selenium, silver, thallium, tin, vanadium or/and zinc).	Input	Refined resource	Hazardous waste	5.288			tonne	Technosphere	
	Input	Refined resource	Laboratory waste	0.061			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Hasardous for the environment	Input	Refined resource	Used film material	128			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Hasardous for the environment	Input	Refined resource	Waste oil	2			m3	Technosphere	
	Input	Refined resource	Waste paint	3.7			tonne	Technosphere	
	Input	Refined resource	Waste with high concentrations of amalga	0.369			tonne	Technosphere	
	Input	Refined resource	Waste with low concentrations of amalgam	0.854			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is hazardous for the environment. Is transported by LB-Transport AB, Falkenberg	Output	Residue	Bleach fixing-bath	161			m3	Technosphere	
Notes: Is hazardous for the environment. Is transported by BTL AB, Göteborg	Output	Residue	Contaminated rags	24			tonne	Technosphere	

	Output	Residue	Contaminated rags	24			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is hazardous for the environment. Is transported by LB-Transport AB, Falkenberg	Output	Residue	Developing-bath	907			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is hazardous for the environment. Is transported by LB-Transport AB, Falkenberg	Output	Residue	Fixing-bath	524			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Hazardous waste (ion exchanging mass containing antimony, arsenic, barium, beryllium, led, cobalt, cupper, chromium, nickel, selenium, silver, thallium, tin, vanadium or/and zinc is exported by Börjes Logistics & Sped AB, Nybro	Output	Residue	Hazardous waste	5.288			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is hazardous for the environment. Is exported by Börjes Logistics & Sped AB, Nybro	Output	Residue	Used film material	128			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The hazardous waste is transported by BTL AB, Göteborg	Output	Residue	Waste paint	3.7			tonne	Technosphere	

About Inventory	
Publication	Environmental report from Stena Miljö AB for 1996, The Environmental Administration in the municipality of Göteborg. -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Lundahl, Hans - Stena Miljö AB Salsmästaregatan 21 422 46 Göteborg Sweden.
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	The function of the technical system is not sufficently described. Contact the company to get the necessary details. The extent of the production is not mentioned in the Environmental report. Because of this we have no functional unit which makes it impossible to use the data direct for life cycle analysis. Though, it is possible to get in touch with the company and try to get some more information.
About Data	
Notes	

SPINE LCI dataset: Storage of ammonia

Administrative	
Finished	Y
Date Completed	1999-01-25
Copyright	
Availability	Public

Technical System	
Name	Storage of ammonia
Functional Unit	1 kg of ammonia (stored)
Functional Unit Explanation	
Process Type	Gate to gate
Site	Hydro Agri AB Box 516 SE-261 24 Landskrona Sweden
Sector	Materials and components
Owner	Hydro Agri AB Box 516 SE-261 24 Landskrona Sweden
Technical system description	At Hydro Agri AB in Landskrona, the ammonia is stored before it is used in the production of fertilisers. This dataset should only be used in the aggregated dataset for production of CAN fertiliser (cradle to gate) as it is specific for the production site in Landskrona.

System Boundaries	
Nature Boundary	The only emission taken into account is N-tot to water.
Time Boundary	The data are figures for production in 1997.
Geographical Boundary	Hydro Agri AB in Landskrona, Sweden.
Other Boundaries	
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData	
Date Conceived	1997-01-01
Data Type	Derived, mixed
Represents	Average electricity generation with stone coal in the UCTPE countries.
Method	
Literature Reference	Miljörapport (official environmental report) 1997, Hydro Agri AB, Box 516, 261 24 Landskrona, Sweden. Personal communication: Ronnie Persson (1998), Hydro Agri AB Landskrona, tel +46 418 76100
Notes	The data represents a total amount for 1996.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Literature: Personal communication: Mats Karlsson (1998), Hydro Agri AB Landskrona, Sweden. tel: +46 418 76100 Notes: Bought from spot market in the Baltic sea, origin is Poland or Russia.	Input	Refined resource	Ammonia	1			kg	Technosphere	Sweden
Method: Total amount of emissions of nitrogen to water (NO-3-N, NH4+-N) originating from the storage of chemicals was divided by the sum of total amounts of nitrogen in ammonia consumed at the site and total amounts of nitrogen in nitric acid produced but not consumed at the site. Literature: Miljörapport (official environmental report) 1997, Hydro Agri AB, Box 516, 261 24 Landskrona, Sweden. Personal communication: Ronnie Persson (1998), Hydro Agri AB Landskrona, tel +46 418 76100	Output	Emission	N-tot	0.0162			kg	Water	Sweden
	Output	Product	Ammonia	1			kg	Technosphere	Sweden

About Inventory	
Publication	Davis J, Haglund C (1999). ''Life Cycle Inventory (LCI) of Fertiliser Production - Fertiliser Products Used in Sweden and Western Europe''. SIK report no. 654. The Swedish Institute for Food and Biotechnology (SIK). Gothenburg, Sweden. -- Data documented by: Jennifer Davis, SIK (The Swedish Institute for Food and Biotechnology). Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	The dataset is intended to be

General Purpose	To generate an inventory over emissions and use of resources for the production of fertilisers used in Sweden.
Detailed Purpose	The purpose was not to compare the production of different fertilisers with each other but to generate a thorough inventory of emissions and use of resources due to the production of different mineral fertilisers. Storage of ammonia is one step in the production of CAN fertiliser at Hydro Agri AB in Landskrona. The data are intended to constitute a useful basis of input information in life cycle assessments of food production systems.
Commissioner	- SIK AB, The Swedish Institute for Food and Biotechnology Box 5401 SE-402 29 Gothenburg Sweden .
Practitioner	Davis, Jennifer and Caroline Haglund - SIK AB Box 5401 402 29 Gothenburg Sweden.
Reviewer	-
Applicability	The dataset is applicable for storage of ammonia at Hydro Agri AB in Landskrona. The dataset is included in the aggregated dataset for production of CAN fertiliser at Hydro Agri AB in Landskrona (cradle to gate).
About Data	Data are collected from the official environmental report distributed by Hydro Agri AB in Landskrona and also by contact with Ronnie Persson at Hydro Agri AB in Landskrona.
Notes	Internal review of the report was performed by: Olle Ramnäs, CTH (Chalmers University of Technology), Berit Mattsson and Magnus Stadig, SIK (The Swedish Institute for Food and Biotechnology).

SPINE LCI dataset: Sugar beet cultivation. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Sugar beet cultivation. ESA-DBP
Functional Unit	1 ha field of sugar beet
Functional Unit Explanation	(NB: no information about the amount of the sugar beet per ha)
Process Type	Cradle to gate
Site	Unknown
Sector	Crop and animal production, hunting etc.
Owner	Unknown
Technical system description	Sugar beet is an ingredient of 'Soy-Dog' which is the object of the study. This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Pea-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Pea cultivation. ESA-DBP - Production of beef. ESA-DBP - Production of pork. ESA-DBP - Rape seed cultivation. ESA-DBP - Wheat cultivation. ESA-DBP - Soy bean processing. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries	
Nature Boundary	Refined resources, energy use and emissions are included in the study.
Time Boundary	The data come from the year 2004.

Geographical Boundary	The study was done for Sweden.
Other Boundaries	Unknown
Allocations	No information about the allocation in the report.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from other report.
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf The particular data come from: Cederberg, C. & Flysjö, A. (2004). Life Cycle Inventory of 23 Dairy Farms in South-Western Sweden. SIK report no.728. Swedish Institute of Food and Biotechnology (SIK), Gothenburg, Sweden
Notes	The data represents a total amount for 1996.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	K	4.40E+01			kg	Other	Sweden
	Input	Refined resource	N	1.06E+02			kg	Other	Sweden
	Input	Refined resource	P	4.30E+01			kg	Other	Sweden
	Input	Refined resource	Pesticides	2.74E+00			kg	Technosphere	Sweden
Notes: NB: Environment not specified in the report	Output	Emission	N2O-N	1.50E+00			kg	Other	Sweden
Notes: NB: Environment not specified in the report	Output	Emission	NH3-N	2.40E+00			kg	Other	Sweden
Notes: NB: Environment not specified in the report	Output	Emission	NO3-N	2.25E+01			kg	Other	Sweden
Notes: NB: Environment not specified in the report	Output	Emission	P	3.00E-01			kg	Other	Sweden
	Output	Product	Sugar beet field	1.00E+00			ha	Ground	Sweden

About Inventory

Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .
Practitioner	Anders Abelmann - Chalmers University of Technology.
Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis.

	Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The data for soy bean cultivation were taken from: Cederberg, C. & Flysjö, A. (2004). Life Cycle Inventory of 23 Dairy Farms in South-Western Sweden. SIK report no.728. Swedish Institute of Food and Biotechnology (SIK), Gothenburg, Sweden

SPINE LCI dataset: Sugarcane cultivation. ESA-DBP

Administrative	
Finished	Y
Date Completed	2009
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Sugarcane cultivation. ESA-DBP
Functional Unit	25.2 kg of sugarcane
Functional Unit Explanation	25.2 kg of sugarcane is used in order to produce 1 kg of LDPE which is the object of the study.
Process Type	Cradle to gate
Site	Unknown
Sector	Crop and animal production, hunting etc.
Owner	Unknown
Technical system description	Excerpt from the report: ''The cultivation of sugarcane is a cycle consisting of one planting run and several ratoon runs. The planting run starts with an intensive soil preparation. It includes mechanical treat-ment like sub soiling and harrowing as well as chemical treatment in form of fertilizer appli-cation. After that, the soil is furrowed, phosphate fertilizers and seed pieces are put into the furrow, which then is closed and another load of fertilizers and herbi-cides is applied. The furrowing and fertilizer application is repeated one to two times in the first year of cultivation. 12-18 months after the planting the cane is ready for harvesting. There are two different harvesting methods: manual harvesting, including the burning of the field before the harvest and mechanical harvesting not necessarily including pre-burning. From the field the harvested cane is transported to the mills and processed to ethanol. Now the ratooning begins. Fertilizers and herbicides are spread and the cane starts regrowing from the left rootstock. Again, after 12-18 months, it can be harvested and a new ratooning starts. In total four ratoonings are done before the old cane is ploughed out. The ratooning is not done infinitely as the harvest decreases with every ratoon run.'' This process is included in the system described in: Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2009--14.pdf Other processes in the CPM Database also included in the above publication: - Ethylene production from cane based ethanol. ESA-DBP - Refinery in crude oil based LDPE production process. ESA-DBP - Polymerization in crude oil based LDPE production process. ESA-DBP - Steam cracking in crude oil based LDPE production process. ESA-DBP

System Boundaries	
Nature Boundary	Excerpt from the report, see 'Publication': ''Outputs accounted for in this study were by-products and emissions released to air. Water emissions were omitted, because of data unavailability for some parts of the sugarcane route. Energy consumed along the process chain was traced back to the extraction of the energy carriers (fuels) needed for its generation.''
Time Boundary	Data for the cultivation come from the year 2004 and energy data from 2008 and 2009.
Geographical Boundary	The study was done for Brazil.

Other Boundaries	Excerpt from the report, see 'Publication': ''The following operations were not included: 1. production and maintenance of capital goods form buildings and machinery (their impacts were set to be insignificant), as well as, 2. Operations included in personnel employment, like supply with housing, food, etc., is not counted.(...) The attributional approach used electricity data representing average Brazilian electricity production. Assumptions set: - building construction & maintenance are not included - equipment construction & maintenance are not included (...) - manual harvesting under attributional LCA - share newly planted cane 0,2; share ratoon cane 0,8 - LHV diesel = 36,4 MJ/l - vehicle type 7-20t; load 50%; speed 49 km/h; euro 2 - LHV ethanol = 31,45 MJ/kg''
Allocations	Excerpt from the report, see 'Publication': ''allocation in attributional approach based on energy content i.e. electricity generated from surplus bagasse in relation to energy content of ethanol''
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''Data availability is a general problem of LCA and the cultivation of sugarcane in Brazil is no exception. Only few authors publish on this issue and the fact that practically all well-to-wheel studies are based on only one author (Macedo) out of these few further limits data diversity and availability. Another problem related to Brazilian sugarcane cultivation is the prediction of technical changes for agricultural operations. Although the Brazilian legislation released different laws concerning the cultivation of sugarcane and its processing, it is uncertain to what extent they will be applied. For these reason, the attributional and consequential assessment of the sugarcane cultivation used the same data originating from a report published by Macedo in 2004. Next to this report, data from Ometto et al. (2009) and Bernesson (2004) were used to assess the environmental impact of the production of fertilizer and pesticides, applied during the sugarcane cultivation. The environmental impact of the consumed fuels (consumption data according to Macedo (2004)) was assessed, using data from the database SPINE LCI (2008) and NTM (2009) - these databases were also used for the environmental assessment of all processes' fuel consumption. Emissions from Land Use change were assessed using data from the California EPA (2009) and Zuurbier and van de Vooren (2008). (...) Attention must be paid that the assessed resource consumption and the resulting release of emissions differ between the attributional and consequential approach.''
Literature Reference	Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2009--14.pdf
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Agricultural chemicals	1.03E+01			g	Technosphere	Brazil
	Input	Refined resource	Fuel	5.20E+00			MJ	Technosphere	Brazil
	Output	Emission	CH4	2.00E-02			g	Air	Brazil
	Output	Emission	CO	1.00E-01			g	Air	Brazil
	Output	Emission	CO2	5.71E+01			g	Air	Brazil
	Output	Emission	HC	4.20E-02			g	Air	Brazil
	Output	Emission	N2O	3.10E-03			g	Air	Brazil
	Output	Emission	NOx	7.00E-01			g	Air	Brazil
	Output	Emission	SO2	1.50E-02			g	Air	Brazil
	Output	Product	Sugarcane	2.55E+04			g	Other	Brazil

About Inventory

Publication	Liptow Ch., Tillman A.-M. (2009). Comparative life cycle assessment of polyethylene based on sugarcane and crude oil. Environmental Systems Analysis, Report 2009:14, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2009--14.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this study is to answer the question, is the use of sugarcane based LDPE in the production of goods and packing in Sweden environmentally preferable to crude oil based LDPE.''
Detailed Purpose	Sugarcane cultivation is a step in the production process of sugarcane based LDPE so it was necessary to investigate the environmental load of it.
Commissioner	Unknown - .

Practitioner	Christin Liptow & Anne-Marie Tillman - Environmental Systems Analysis, Chalmers University of Technology.
Reviewer	Tillman, Anne-Marie - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Sugarcane cultivation is a step in a production process of sugarcane based LDPE which was the object of the study. The production process starts with cane cultivation, ethanol production, ethylene production, polymerization, use phase (which is not included in the study) and ends with incineration. In the study sugarcane based- was compared with oil based- LDPE. NB: in the report two approaches were investigated: attributional and consequential. For consequential approach see the report.

SPINE LCI dataset: Surface Coating of bearing roller

Administrative	
Finished	Y
Date Completed	2002-12-12
Copyright	
Availability	Public

Technical System	
Name	Surface Coating of bearing roller
Functional Unit	1 bearing 1 year
Functional Unit Explanation	The function of a bearing at its place in the soft calender section, with all its components.
Process Type	Unit operation
Site	Halmstad
Sector	
Owner	Halmstad
Technical system description	This activity describes a process step included in the process coating of bearing rollers which takes place at Baltzer, Sweden. The rollers are manufactured to SKF spherical roller bearing 232/530. Surface coating of bearing roller: The surface of the roller is coated with a multi-layered coating via high vacuum PVD. The chamber, that can be loaded with 24 rollers of the size 232/530, is evacuated from air. Then the rollers are heated via induction to reach a temperature suitable for the condensation of metal particles. Argon and acetylene are introduced in the chamber and a potential is applied. Argon is ionised, some ions etch the roller surface. Other hit the targets of chrome or tungsten carbide and this causes atoms from the target material to vaporise and sputter against the rollers where they condense. First a thin binding layer of chrome is created, then several layers of WC/C. The carbon layer is created when the argon ions hits the acetylene gas. The chamber is cooled with helium. Afterwards the rollers are treated with a corrosive protecting agent, Tectyl. For further reading about Coating of bearing rollers read Environmental Report from year 2001 Balzers Sandvik Coatings AB and Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002.

System Boundaries	
Nature Boundary	The system has an inflow of target materials, gases, energy and rollers, that is they all come from the technosphere. The outflows are coated rollers and waste gas that leaves for the technosphere. Emissions to air and water are not included in this dataset since no information was available.

Time Boundary	The report from which the data is taken is published year 2001. No changes planned for the nearest future.
Geographical Boundary	This coating process takes place in Halmstad, Sweden.
Other Boundaries	The material on the targets cannot be fully used. A chrome target for example weighs 7,3 kg new, including the steel frame. Only about 1 kg crome is used, then the target is wasted. In this study only the amount of crome used for the coating is handled for simplicity reasons. Production of electricity is not included in this dataset.
Allocations	The total amount of energy and materials used during a year is divided to give an equal amount for each coating batch. This amount is then divided in 24, since there are 24 rollers size 232/530 in each batch. This gives the amount of used energy and materials for the coating of one roller. There are 36 rollers in each roller bearing size 232/530. The coated bearings lifetime is 6 years, which means that all numbers are multiplied with 6 to give the yearly consumption.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002-09-12 - 2002-12-31
Data Type	Economical information
Represents	See 'Function'
Method	All data have been measured by the company Balzers and are reported in their environmental report for year 2001. The calculations are based on economical value, purchased amount of cleaning agents.
Literature Reference	Environmental Report 2001 - Balzers Sandvik Coating AB.
Notes	Data for attributional approach.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: The production of the chrome target is not included, only use of the metal.	Input	Natural resource	Chromium in ore	1.98			g	Ground	Liechtenstein
Notes: The production of the tungsten carbide target is not included, only use of the ceramic.	Input	Natural resource	WC	1.74			g	Ground	United States
Notes: Acetylene is also named ethene. Provided by Air Liquid.	Input	Refine resource	Acetylene	108			l	Technosphere	Europe
Notes: Argon is a by-product stream from air separation into nitrogen and oxygen, and is therefore described as a resource. Provided by Air Liquid.	Input	Refine resource	Ar	46.2			l	Technosphere	Europe
Notes: The rollers are heated via induction. Electricity is also consumed when creating the potential.	Input	Refine resource	Electricity	82.5			kWh	Technosphere	Sweden
Notes: Argon is a by-product stream from air separation into nitrogen and oxygen, and is therefore described as a resource. Provided by Air Liquid.	Input	Refine resource	He	120			l	Technosphere	Europe
	Input	Refine resource	Kraftliner	228			g	Technosphere	
	Input	Refine resource	LDPE	2.7			g	Technosphere	
Notes: For further information see Functional unit explanation.	Input	Refine resource	roller	55.2			kg	Technosphere	Sweden
Notes: Corrosion protective agent provided by Tectyl.	Input	Refine resource	Tectyl 472	4.56			g	Technosphere	Sweden
Notes: For further information see Functional unit explanation.	Output	Product	roller	55.2			kg	Technosphere	Sweden

About Inventory

Publication	Environmental Report from year 2001 Balzers Sandvik Coatings AB Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002. ------------- Data documented by Sandra Häggström, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-03-21.
Intended User	Product developer at SKF and B
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.

Detailed Purpose	The purpose for our study is to compare a coated roller bearing to a non-coated, from cradle to grave. The coating is preceeded by a cleaning treatment.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	The dataset describes a coating process that is conducted in order to strengten the surface of metal components and tools. Care has to be taken to substrate size, both the energy consumption and the target material consumption depends on substrate size. The dataset is compiled for rollers RS-232/530 C in SKF roller bearings size 232/530.
About Data	All data are gathered from a specific site, the Balzers Sandvik Coatings AB in Halmstad, Sweden. The data have been measured by the company (Balzers) and is reported in their environmental report for year 2001. The calculations are based on economical value, purchased amount of chemicals.
Notes	

SPINE LCI dataset: Sweden, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Sweden, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Sweden
Sector	Energyware
Owner	Sweden
Technical system description	The generation of electricity with different power generating systems in Sweden during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'
Method	The data are collected from IEA Statistics.

Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	3088			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	3155			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	317			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	3264			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	431			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	60			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	73583			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	74328			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	158226			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998

	Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Swedish average electricity AGGR

Flow Chart
This data set transparently reported, including a flowchart where each process is individually described

Administrative	
Finished	Y
Date Completed	1999
Copyright	
Availability	

Technical System	
Name	Swedish average electricity AGGR
Functional Unit	1 kWh
Functional Unit Explanation	
Process Type	Cradle to gate
Site	
Sector	Grid electricity and district heat
Owner	
Technical system description	The Swedish average electricity production comes from hydropower, nuclear power, combined heat and power plant, oil condensing plants, gas turbines, and wind power. Thus, the Swedish electricity production system consists of a large number of power plants based on different technique and with very different environmental impact. The base in the system is hydropower and nuclear power. The remaining part is mainly produced by fossil fuels through combined heat and power. A small share of the electricity is produced in condensing plants or gas turbines. The thermal power stations are primarily run during the winter half, when the supply of hydropower and nuclear power are not sufficient to meet the demand for electricity. In order to know more about the technical system of each power plant included in this study, see the data sets, respectively.

Flowchart
Click on flowchart to open each data set description

System Boundaries	
Nature Boundary	

Time Boundary	
Geographical Boundary	
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Natural resource	Area	0.004557285			m2	Ground	
	Input	Natural resource	Bauxite	6.64162E-05			g	Ground	
	Input	Natural resource	Coal	0.002138963			kWh	Other	
	Input	Natural resource	Copper ore	1.034527578			g	Ground	
	Input	Natural resource	Fuel wood	26.268			g	Ground	
	Input	Natural resource	Iron ore	0.0333659			g	Ground	
	Input	Natural resource	Lead ore	0.01192958			g	Ground	
	Input	Natural resource	Natural gas	0.000581091			kWh	Other	
	Input	Natural resource	Uranium ore	0.60264			g	Ground	
	Input	Natural resource	Wood	0.00232794			g	Ground	
	Input	Refined resource	Ammonia	0.007816416			g	Technosphere	
	Input	Refined resource	Bio fuel	1.27535E-06			kWh	Technosphere	
	Input	Refined resource	Electricity	0.001597429			kWh	Technosphere	
	Input	Refined resource	Electricity	0.004959524			kWh	Technosphere	
	Input	Refined resource	H2SO4	0.080820534			g	Technosphere	
	Input	Refined resource	Heavy oil	0.018749692			kWh	Technosphere	
	Input	Refined resource	NaOH	0.00263014			g	Technosphere	
	Input	Refined resource	Nitric acid	0.00379566			g	Technosphere	
	Output	Emission	CO	0.81325842			g	Air	
	Output	Emission	CO2	27.6052841			g	Air	
	Output	Emission	HC	0.00376291			g	Air	
	Output	Emission	NOx	0.035847185			g	Air	
	Output	Emission	N-tot	0.001242013			g	Water	
	Output	Emission	Particles	0.006122612			g	Air	
	Output	Emission	SO2	0.01232593			g	Air	
	Output	Product	Electricity	1			kWh	Technosphere	
	Output	Residue	Building waste	0.0333922			g	Technosphere	
	Output	Residue	Highly active rad ac waste	0.0220158			g	Technosphere	
	Output	Residue	Low active rad ac waste	13.3164			ug	Technosphere	
	Output	Residue	Low active rad ac waste	5.832E-09			m3	Technosphere	
	Output	Residue	Medium active rad ac waste	5.832E-09			m3	Technosphere	
	Output	Residue	Other rest products	49.4021121			g	Technosphere	

About Inventory

Publication	
Intended User	
General Purpose	
Detailed Purpose	
Commissioner	
Practitioner	
Reviewer	
Applicability	

About Data	
Notes	

SPINE LCI dataset: Swedish electricity production system

Administrative	
Finished	Y
Date Completed	1997-05-01
Copyright	
Availability	

Technical System	
Name	Swedish electricity production system
Functional Unit	1 kWh
Functional Unit Explanation	Production of 1 kWh electricity
Process Type	Other
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	The Swedish electricity production system consists of a large number of power plants based on different technique and with very different environmental impact. The base in the system is hydropower and nuclear power. The remaining part is mainly produced by fossil fuels through combined heat and power. A small share of the electricity is produced in condensing plants or gas turbines. The thermal power stations are primarily run during the winter half, when the supply of hydropower and nuclear power are not sufficient to meet the demand for electricity.

System Boundaries	
Nature Boundary	N/A
Time Boundary	The data is applicable for a normal year of electricity production.
Geographical Boundary	Only electricity produced in Sweden is considered. Import or export of electricity is not included.
Other Boundaries	
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'
Method	The share of the different power sources of the total electricity production have been calculated by dividing the total electricity production of each power source with the total electricity production in Sweden during a normal year of electricity production. The total electricity production during a normal year is 144 TWh.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	The power sources that produce the different shares of electricity can be found under Notes for each specific flow into the system.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Electricity produced by wind power.	Input	Refined resource	Electricity	.001000			kWh	Technosphere	

Notes: Electricity produced by gas turbine power.	Input	Refined resource	Electricity	.001000			kWh	Technosphere	
Notes: Electricitty produced by condensing power.	Input	Refined resource	Electricity	.004000			kWh	Technosphere	
Notes: Electricity produced by combined heat and power	Input	Refined resource	Electricity	.066000			kWh	Technosphere	
Notes: Electricity produced by hydro power	Input	Refined resource	Electricity	.442000			kWh	Technosphere	
Notes: Electricity produced by nuclear power.	Input	Refined resource	Electricity	.486000			kWh	Technosphere	
	Output	Product	Electricity	1			kWh	Technosphere	

About Inventory	
Publication	-- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	
General Purpose	
Detailed Purpose	To calculate the environmental load from electricity produced in Sweden, using the data for the environmental impact of electricity production of different power sources found in Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB, 1996
Commissioner	
Practitioner	Skalsky, Edmund - Kraftverksföreningen Olof Palmes gata 31, 6 tr. 101 53 Stockholm .
Reviewer	
Applicability	The environmental impact of the electricity production system can be calculated using data for the environmental impact of different power sources found in Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB, 1996. Data for fuel production, operation and maintenace and handling of rest products for the following power sources can be used from this report: *Hydropower* *Nuclear power* *Combined heat and power* with a conventional steam cycle with a circulating fluidisation bed, equipped with flue gas condensing equipment (CFB-KVV), fired with wood fuel *Oil condensing power* *Gas turbine power* All electricity produced from combined heat and power has been assumed to be produced by wood fuel fired combined heat and power plants. This is a reasonable assumption since the share of electricity produced by combined heat and power is small, compared to the total electricity production. Combined heat and power plants are also being rebuilt to be fired with wood fuels. The data are applicable for a normal year of electricity production. A normal year means a year with normal water supply, i.e. medianflow during the flowseries 1950-1990, and normal supply in the twelve Swedish nuclear power units. Import or export is not included. It is not possible to give the normal import or export since the variations during the year are quite large. With the normal electricity production that is stated (144 TWh) and the electricity use during the last 2 years (142 TWh), there has been a net export of approx. 2 TWh.
About Data	Kraftverksföreningen assemble data for the production on a weekly and monthly basis from all major electricity producers. The National Statistics Office of Sweden assemble data for both gross and net production from every electricity producer in Sweden on an annual basis.
Notes	

SPINE LCI dataset: Swedish red paint manufacturing and application. ESA-DBP

Administrative	
Finished	Y
Date Completed	1999
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System

Name	Swedish red paint manufacturing and application. ESA-DBP
Functional Unit	1 m2 * year
Functional Unit Explanation	1 m2 painted with Swedish red paint over one year.
Process Type	Gate to gate
Site	Not applicable
Sector	Consumer goods
Owner	Not applicable
Technical system description	Swedish red paint is an exterior coating of buildings. The data includes manufacturing of paints and paint components, transporatation of materials and products and application of paints. This process is included in the system described in: Blanco-Rosete S. R., 2002, LCA data structure and time series related to construction and maintenance in Sweden. Environmental Systems Analysis report 2002:14, Chalmers University of Technology, Gothenburg, Sweden Other processes in the CPM Database also included in the above publication: Clay roof tile manufacturing. ESA-DBP Exterior coating (Swedish red paint) maintenance. ESA-DBP Pine window production. ESA-DBP Floor maintenance. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report (see 'Publication'): ''The study includes manufacturing of paints and paint components, transporatation of materials and products and application of paints. However the study is not clear if the manufacture of paint components starts from the raw material.''
Time Boundary	1999
Geographical Boundary	Sweden
Other Boundaries	Excerpt from the report (see 'Publication): ''The study includes manufacturing of paints and paint components, transporatation of materials and products and application of paints.''
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1999
Data Type	Unspecified
Represents	See 'Function'.
Method	Unknown.
Literature Reference	Häkkinen T, 1999, Environmental Impact of Coated Exterior Wooden Cladding. VTT Building Technology. Finland
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Heavy fuel oil	0.276			MJ	Technosphere	
	Input	Refined resource	Iron-sulphate	0.0008			kg	Technosphere	Sweden
	Input	Refined resource	Pigment	0.0032			kg	Technosphere	
	Input	Refined resource	Rye	0.0016			kg	Technosphere	
	Input	Refined resource	Water	0.0132			kg	Technosphere	Sweden
	Output	Emission	Alkanes	1.66E-07			kg	Air	Sweden
	Output	Emission	Alkenes	8.28E-09			kg	Air	Sweden
Notes: Aromates C9-C10	Output	Emission	Aromates	4.14E-08			kg	Air	
	Output	Emission	As	3.59E-09			kg	Air	Sweden
	Output	Emission	Benzo(a)pyrene	8.28E-12			kg	Air	Sweden
	Output	Emission	Ca	2.21E-08			kg	Air	Sweden
	Output	Emission	Cd	9.11E-09			kg	Air	Sweden
	Output	Emission	CO	4.14E-06			kg	Air	Sweden
	Output	Emission	CO	9.11E-09			kg	Air	Sweden
	Output	Emission	CO2	0.0082			kg	Air	Sweden
	Output	Emission	CO2	0.0215			kg	Air	Sweden
	Output	Emission	Cr	4.42E-09			kg	Air	Sweden
	Output	Emission	Cu	1.35E-08			kg	Air	Sweden
	Output	Emission	Fe	4.97E-08			kg	Air	Sweden

	Output	Emission	Formaldehyde	1.24E-07			kg	Air	Sweden
	Output	Emission	HCl	3.97E-07			kg	Air	Sweden
	Output	Emission	HF	3.97E-08			kg	Air	Sweden
	Output	Emission	Hg	4.14E-11			kg	Air	Sweden
	Output	Emission	Methane	1.22E-05			kg	Air	Sweden
	Output	Emission	Mo	4.42E-09			kg	Air	Sweden
	Output	Emission	N2O	4.42E-07			kg	Air	Sweden
	Output	Emission	Na	2.07E-07			kg	Air	Sweden
	Output	Emission	Ni	1.79E-07			kg	Air	Sweden
	Output	Emission	NOx	7.62E-05			kg	Air	Sweden
	Output	Emission	PAH	1.38E-10			kg	Air	Sweden
	Output	Emission	Particles	2.68E-05			kg	Air	Sweden
	Output	Emission	Pb	1.57E-08			kg	Air	Sweden
	Output	Emission	Propane	8.28E-09			kg	Air	Sweden
	Output	Emission	Se	3.31E-09			kg	Air	Sweden
	Output	Emission	SO2	0.000113			kg	Air	Sweden
	Output	Emission	Toluene	8.28E-09			kg	Air	Sweden
	Output	Emission	V	7.18E-07			kg	Air	Sweden
	Output	Emission	VOC	1.18E-05			kg	Air	Sweden
	Output	Emission	Zn	1.10E-08			kg	Air	Sweden
	Output	Product	Swedish red paint	1			m2 year	Technosphere	

About Inventory	
Publication	Blanco-Rosete S. R., 2002, LCA data structure and time series related to construction and maintenance in Sweden. Environmental Systems Analysis report 2002:14, Chalmers University of Technology, Gothenburg, Sweden
Intended User	LCA practitioners.
General Purpose	This process data set is recalculated to fit in the Master Thesis given in 'Publication'. Excerpt from the report (see 'Publication'): ''Construction, building maintenance and housing management contribute to a large extent to the environmental impact. When housing owners and managers perform their activities they should be aware of the environmental effects they cause. The environmental impact of existing houses could be addressed and diminished within the possibilities of a clever management.''
Detailed Purpose	Excerpt from the report (see 'Publication'): ''This master thesis descibes and defines a building system model for a multi-family house in Gothenburg over a 30 year period from 1970 to 2002 . The model was used to collect environmental impact information regarding materials or products used in the construction and maintenance of a building . The environmental impact ofa a multi-family house was evaluated through a Life Cycle Assessment (LCA). Finally to account the long sevice lifetime of a multi-family house two case studies were carried out to test if the use of Time series can illustrate the environmental impact of maintenance activities caused by decisionmaking in housing management.''
Commissioner	Not applicable - .
Practitioner	Sergio R. Blanco-Rosete - .
Reviewer	Birgit Brunklaus - Environmental Systems Analysis
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	The functional unit in the original data set was the amout of paint covering 20 square meter of surface with 98% coverage. When the calculations for the LCI of the new building system model were performed the original data was modified to fit according to the functional unit of this study. ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-09-21 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Swedish reinforcement steel mix

Administrative	
Finished	Y

Date Completed	1996-10-01
Copyright	
Availability	Public

Technical System

Name	Swedish reinforcement steel mix
Functional Unit	kg
Functional Unit Explanation	1 kg reinforcement steel
Process Type	Other
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	This data represents an allocation method and not a technical system. The allocation method reflects the Swedish market of reinforcement steel.

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	
Allocations	Several principles for how the environmental load has to be split, when the material goes through several life cycles, are further described and discussed in Lindfors L-G et al. (LCA-NORDIC. Technical Reports No 1-9. Nord 1995:502, Nordic Council of Ministers, Copenhagen, 1995). In this study we have for steel chosen to use the 50/50 method. 50% of the environmental load caused by primary production and waste management are allocated to the first life-cycle and the remaining 50% are allocated to the last life-cycle (i.e. when the material is taken out of the defined system). Of environmental impacts caused by a recycling process between two user periods, 50% are allocated to the previous and 50% to the following life cycle. When using the 50/50 method on reinforcement steel, the data mix will consist of 50% of the previous recycling process (100% scrap-based production) and 50% of the ore-based production since. Thus, the data mix used in the calculations will for reinforcement steel be 50% ore-based and 50% scrap-based production.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'.
Method	Allocation principle
Literature Reference	Lindfors L-G et al. LCA-NORDIC. Technical Reports No 1-9. Nord 1995:502, Nordic Council of Ministers, Copenhagen, 1995
Notes	This method is based on a 50/50 allocation principle (Lindfors L-G et al., see Literature reference) in which the Swedish market is reflected. The method results in reinforcement steel consisting of 50% ore-based and 50% scrap-based steel. You can find the data for ore-based and scrap-based steel production in this Database at: Name: Ore-based steel production Category: Cradle to gate Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology Name: Scrap-based steel production Category: Gate to gate Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Ore-based steel	Input	Refined resource	Steel	0.5			kg	Technosphere	
Notes: Scrapbased steel	Input	Refined resource	Steel	0.5			kg	Technosphere	
	Output	Product	Steel	1			kg	Technosphere	

About Inventory

Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden -- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology --
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural concrete and steel frames in buildings during the whole life-cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of steel
Commissioner	- Finncement Finland .
Practitioner	Björklund T., Jönsson Å., Tillman A-M - Technical Environmental Planning, CTH Sven Hultins Gata 8 412 96 Göteborg Sweden .
Reviewer	
Applicability	There are several principles for how the environmental load has to be split when the material goes through many life cycles. These are further described and discussed in Lindfors L-G et al. (LCA-NORDIC. Technical Reports No 1-9. Nord 1995:502, Nordic Council of Ministers, Copenhagen, 1995). You can find the data for ore-based and scrap-based steel production in this Database: Name: Ore-based steel production Category: Cradle to gate Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden Name: Scrap-based steel production Category: Gate to gate Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology, Göteborg, Sweden
About Data	This 50/50-allocation method is chosen to promote the recycling of steel. According to discussions with the steel industry, the main part of reinforcement steel used in Sweden is also produced in Sweden, though some reinforcement steel is also imported. It is probable that also the imported products are based on scrap. Thus, in the calculations it is assumed that all reinforcement steel used in Sweden is based on scrap.
Notes	

SPINE LCI dataset: Swedish sheet steel mix

Administrative	
Finished	Y
Date Completed	1996-10-01
Copyright	
Availability	Public

Technical System	
Name	Swedish sheet steel mix
Functional Unit	kg
Functional Unit Explanation	1 kg sheet steel
Process Type	Other
Site	Sweden
Sector	Materials and components
Owner	Sweden
Technical system description	This data represents an allocation method and not a technical system. The allocation method reflects the Swedish market of sheet steel.

System Boundaries

Nature Boundary	
Time Boundary	
Geographical Boundary	Sweden
Other Boundaries	
Allocations	In this study we have chosen to use the 50/50 method. 50% of the environmental load caused by primary production and waste management are allocated to the first life cycle, and the remaining 50% are allocated to the last life-cycle (i.e. when the material is taken out of the defined system). Of environmental impacts caused by a recycling process between two user periods, 50% are allocated to the previous and 50% to the following life cycle. For sheet steel products, it is assumed in the calculations that all products are recycled after use. This means that, when using the 50/50 method, the input data in the calculation model will for 1 kg sheet steel consist of 50% of the environmental load of the average sheet steel used today (75% ore-based and 25% scrap-based production) and 50% of data for the succeeding recycling process (100% scrap-based steel production). The final data mix for sheet steel will then be 37.5% ore-based and 62.5% scrap-based steel production. Several principles for how the environmental load has to be split, when the material goes through several life cycles, are further described and discussed in Lindfors L-G et al. (LCA-NORDIC. Technical Reports No 1-9. Nord 1995:502, Nordic Council of Ministers, Copenhagen, 1995).
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	
Data Type	
Represents	See 'Function'.
Method	Allocation principle
Literature Reference	Lindfors L-G et al. LCA-NORDIC. Technical Reports No 1-9. Nord 1995:502, Nordic Council of Ministers, Copenhagen, 1995
Notes	This method is based on a 50/50 allocation principle (Lindfors L-G et al., see Literature reference) in which the Swedish market is reflected. The method results in sheet steel consisting of 37.5% ore-based and 62.5% scrap-based steel. You can find the data for ore-based and scrap-based steel production in this Database at: Name: Ore-based steel production Category: Cradle to gate Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology; Göteborg; Sweden Name: Scrap-based steel production Category: Gate to gate Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology; Göteborg; Sweden

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Ore-based steel	Input	Refined resource	Steel	0.375			kg	Technosphere	
	Input	Refined resource	Steel	0.625			kg	Technosphere	
	Output	Product	Steel	1			kg	Technosphere	

About Inventory

Publication	LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; TEP; CTH; Göteborg; Sweden -- Data documented by: Maria Erixon, project employed for the database project at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Thomas Björklund, Technical Environmental Planning, Chalmers University of Technology --
Intended User	To make an LCA of building fra
General Purpose	Among others, to analyse and assess the environmental impact of structural concrete and steel frames in buildings during the whole life-cycle by using the method of LCA as a tool.
Detailed Purpose	To calculate the environmental load of steel
Commissioner	- Finncement and Trätek (The Swedish Institute for Wood Technology Research) Box 5609 S-114 86 Stockholm Sweden.
Practitioner	Björklund T., Jönsson Å., Tillman A-M - Technical Environmental Planning, CTH Sven Hultins Gata 8 412 96 Göteborg Sweden .

Reviewer	
Applicability	You can find the data for ore-based and scrap-based steel production in this Database: Name: Ore-based steel production Category: Cradle to gate Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology; Göteborg; Sweden Name: Scrap-based steel production Category: Gate to gate Publication: LCA of Building Frame Structures Environmental Impact over the Life Cycle of Concrete and Steel frames; Björklund T., Jönsson Å., Tillman A-M.; Report 1996:8; Technical Environmental Planning; Chalmers University of Technology; Göteborg; Sweden There are several principles for how the environmental load has to be split when the material goes through many life cycles. These are further described and discussed in Lindfors L-G et al. (LCA-NORDIC. Technical Reports No 1-9. Nord 1995:502, Nordic Council of Ministers, Copenhagen, 1995).
About Data	This 50/50-allocation method is chosen to promote the recycling of steel. In the calculations it is roughly assumed that: -All sheet steel produced in Sweden is ore-based. -All imported sheet steel is 50% ore-based and 50% scrap-based. -Of the sheet steel used in Sweden today 50% is produced in Sweden and 50% is imported. Thus, the data mix used in the calculations for sheet steel will consist of 75% ore-based and 25% scrap-based steel production. However, all data are based on Swedish production since these are the data available.
Notes	

SPINE LCI dataset: Switzerland, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Switzerland, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Switzerland
Sector	Energyware
Owner	Switzerland
Technical system description	The generation of electricity with different power generating systems in Switzerland during the year 1998. Switzerland includes Liechtenstein.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	1177			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	25830			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	3			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	33471			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	376			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	8			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	846			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	61711			GWh	Technosphere	

About Inventory

Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. --- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden ---
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version

	The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Tankers

Administrative	
Finished	Y
Date Completed	1994-04-01
Copyright	
Availability	Public

Technical System	
Name	Tankers
Functional Unit	tonkm
Functional Unit Explanation	The energy use and exhaust emissions are calculated with reference to the transportation of 1 ton goods, 1 kilometre.
Process Type	Unit operation
Site	
Sector	Sea transport
Owner	
Technical system description	Operation of a tanker

System Boundaries	
Nature Boundary	Emissions to air from combustion of the fuel are included. Other environmental impacts from the operation of the ship are not included.
Time Boundary	The aim was that the figures would represent the active fleet in 1992
Geographical Boundary	Sweden and other countries with a similar fleet

Other Boundaries	Utilisation level of the ship is not known. *Not included in the system:* Production and distribution of the fuel Manufacture and maintenance of the ship
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1990-1994
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	Data compiled from different literature sources. The emissions were calculated from emission factors; the emission factor for each specific substance was multiplied with the energy use for the given transport. The emission factors were: SO2 1,28 g/MJ NOx 2,5 g/MJ CO 0,22 g/MJ CO2 72 g/MJ HC 0,06 g/MJ Particles 0,11 g/MJ For details on how the emission factors were obtained, see metadata for each specific substance. Metadata for CO and HC can be found under CO. Metadata for SO2 and particles can be found under SO2.
Literature Reference	Tillman, A-M. \`Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.\` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995
Notes	-

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes:	Input	Cargo	Cargo	1.000000			tonne	Technosphere	
Date concieved: 1990 Data type: Modeled data Method: The energy use for tankers were calculated for a *specific ship* by Habersatter. Data for the ship were: Size >40 000 BRT Specific run capacity 0,21 kW/ton Specific fuel use 0,35 kg/kWh Average speed 15 km/h This gives a fuel use of 0,0026 kg/tonkm or 0,11 MJ/tonkm (heat value for oil 41,0 MJ/kg). The data were supplied by a shipping company Literature: Habersatter, K. \`Oekobilanz von Packstoffen - Stand 1990\`. Schriftenreihe Umwelt nr 132, Bundesamt fur Umwelt, Walt und Landschaft (BUWAL), Bern 1991. Notes: *Reviewers comment:* The energy use for different types of ships can vary depending on e. g. size, shape of the hull, hydrodynamic properties and engine strength. This can give a very broad distribution in the energy use depending on which individu	Input	Refined resource	Heavy oil	0.11			MJ	Technosphere	
Notes:	Output	Cargo	Cargo	1.000000			tonne	Technosphere	
Date concieved: 1992 Data type: Unspecified Method: Lenner has calculated average emission factors in g/tonkm, intended to represent an average value for all shipping in Sweden. They are therefore calculated for a combination of several types of ships. Emission factors in g/MJ were obtained by division of the emission factors in g/tonkm by the average energy use (0,051 g/MJ). Lenner has not stated how the values were retrieved. Literature: Lenner, M. \`Energiförbrukning och avgasemission för olika transporttyper\` VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 Notes:	Output	Emission	CO	0.02			g	Air	
Date concieved: 1992 Data type: Modeled data Method: The emission factor was calculated from the fuel use (0,18 g/MJ) using the carbon content in diesel. The data used in the calculation was: Heat value: 42,82 MJ/kg Density: 0,83 kg/dm3 CO2 emission: 2,61 kg CO2/dm3 fuel Literature: Lenner, M. \`Energiförbrukning och avgasemission för olika transporttyper\` VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 Notes:	Output	Emission	CO2	7.9			g	Air	
Notes:	Output	Emission	HC	0.007			g	Air	

Date concieved: 1990-1992 Data type: Unspecified Method: Lenner has calculated an *average emission factor* in g/tonkm, intended to represent an average value for all shipping in Sweden. They are therefore calculated for a combination of several types of ships. Emission factors in g/MJ were obtained by division of the emission factors in g/tonkm by the average energy use (0,051 g/MJ). The data was based on figures found in a document written by the Swedish Environmental Agency (Planeringsunderlag..). The emission factors in this document are given for four-stroke engines, and based on an investigation of exhaust emissions from shipping in Sweden made by Alexandersson. Data on specific emissions given in Alexandersson were mainly based on data from laboratory measurements by engine manufacturers but also measurements onboard three ships and other projects that has conducted measurements onboard sailing ships. Literature: Alexandersson, A. ''Sjöfartens utsläpp av avgaser'' TFB-meddelande nr 164, Transportforskningsdelegationen, Stockholm 1990. Lenner, M. ''Energiförbrukning och avgasemission för olika transporttyper'' VTI-meddelande nr 718, Statens Väg- och Trafikinstitut, 1993 Planeringsunderlag för samordnad investeringsplanering 1994-2003. Statens Naturvårdsverk 1992-04-15 Notes:	Output	Emission	NOx	0.28			g	Air
Notes:	Output	Emission	Particles	0.01			g	Air
Date concieved: 1990 Data type: Unspecified Method: Exhaust emission factors in g/tonkm can be read in figure 25 in Alexandersson. To obtain emission factors in g/MJ, Tillman has divided the emission factors in g/tonkm with an energy use of 0,47 MJ/tonkm Figure 25 in Alexandersson is based on total exhaust emissions and transportation by domestic shipping in Sweden 1987. It is not however clear how the background data for figure 25 were collected. Literature: Alexandersson, A. ''Sjöfartens utsläpp av avgaser'' TFB-meddelande nr 164, Transportforskningsdelegationen, Stockholm 1990.	Output	Emission	SO2	0.14			g	Air

About Inventory

Publication	Tillman, A-M. \`Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.\` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995 -- Documentation and review of the report done by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	To fulfil a need for *standard values* to calculate energy use and exhaust emissions from goods transports.
Detailed Purpose	An update of standard values for energy use and exhaust emissions from an earlier investigation in: *Tillman, A-M., Baumann, H., Eriksson, E., Rydberg, T.* \`Livscykelanalyser för förpackningsmaterial - beräkning av miljöbelastning\` SOU 1991:77, Allmänna förlaget, Stockholm, 1991.
Commissioner	- .
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	*Reviewers comment:* The data should be used with great care. The energy use for different types of ships can vary depending on e.g. size, shape of the hull, hydrodynamic properties and engine strength. This can give a very broad distribution in the energy use depending on which individual ships the energy use were based.
About Data	The emissions were calculated from the energy use and emission factors. The emission factors that were used and the basis for them can be found in general metadata.
Notes	

SPINE LCI dataset: TDI - PUR precursors

Administrative	
Finished	Y
Date Completed	1996
Copyright	
Availability	

Technical System	
Name	TDI - PUR precursors
Functional Unit	1 kg TDI
Functional Unit Explanation	
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	This set of data concerns the production of the polyurethane precursors (TDI, MDI, Polyols) and not the production of the polyurethane foam. The principal raw materials for polyurethane precursors are crude oil and natural gas. The diisocyantes having the greatest commercial importance originate from the aromatic content (benzene and toluene), while the polyols come almost exclusively from the aliphatic content. Diisocyanates are obtained by phosphogenation of daimines which are produced, via a number of intermediates steps, from aromatic hydrocarbons. The diisocyanate with the greatest technical importance are tolyene diisocyanante (TDI) and diphenylmethane diisocyanate (MDI). The polyols used in polyurethane production are predominantly hydroxy-polyesters. They are produced by alkoxylation. Depending on the degree of cross-linking required, the starting alcohols used for hydroxy-polyethers may be divalent glycols (ethylene, propylene and other glycols) or multivalent alcohols. The epoxides used are generally propylene oxide and ethylene oxide.

System Boundaries	
Nature Boundary	Water- and Air- emissions out of our system Resource input to our system
Time Boundary	
Geographical Boundary	Europe
Other Boundaries	
Allocations	Unspecified
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	98/01/26
Data Type	Unspecified
Represents	See 'Function'.
Method	Normal LCI method for the production of 1 kg of TDI (from the cradle to the gate)
Literature Reference	Tillman, A-M. \`Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.\` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995
Notes	-

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Bauxite	130			mg	Technosphere	Europe
	Input	Refined resource	Electricity	19			MJ	Technosphere	Europe
	Input	Refined resource	Heavy oil	20			MJ	Technosphere	Europe
	Input	Refined resource	Iron ore	530			mg	Technosphere	Europe
	Input	Refined resource	Limestone	78500			mg	Technosphere	Europe
	Input	Refined resource	NaCl	288000			mg	Technosphere	Europe
	Input	Refined resource	Natural gas	70			MJ	Technosphere	Europe
	Input	Refined resource	Natural sand	580			mg	Technosphere	Europe
	Input	Refined resource	SO2	77000			mg	Technosphere	Europe
	Input	Refined resource	Water	416100000			mg	Technosphere	Europe
	Output	Emission	BOD	200			mg	Water	Europe
	Output	Emission	CO	3300			mg	Air	Europe
	Output	Emission	CO2	4760000			mg	Air	Europe
	Output	Emission	COD	1400			mg	Water	Europe
	Output	Emission	H2	570			mg	Air	Europe
	Output	Emission	H2S	5			mg	Air	Europe
	Output	Emission	H2SO4	680			mg	Water	Europe
	Output	Emission	HC	17300			mg	Air	Europe
	Output	Emission	HC	300			mg	Water	Europe
	Output	Emission	HCl	220			mg	Air	Europe
	Output	Emission	HF	10			mg	Air	Europe
	Output	Emission	Metals	260			mg	Water	Europe
	Output	Emission	Metals	5			mg	Air	Europe
	Output	Emission	NOx	28500			mg	Air	Europe
	Output	Emission	Oil	60			mg	Water	Europe
	Output	Emission	Organic compounds	1800			mg	Water	Europe
	Output	Emission	Particles	7100			mg	Air	Europe
	Output	Emission	Phenol	3			mg	Water	Europe
	Output	Emission	SOx	18500			mg	Air	Europe
	Output	Emission	Sulphates	36100			mg	Water	Europe
	Output	Emission	Susp solids	12100			mg	Water	Europe
	Output	Product	TDI	1			kg	Technosphere	Europe
	Output	Residue	Ashes	27400			mg	Technosphere	Europe
	Output	Residue	Industrial waste	205000			mg	Technosphere	Europe
	Output	Residue	Mineral waste	183000			mg	Technosphere	Europe

About Inventory

Publication	Eco profiles ot the European plastics industry Report 9 : Polyurethane precursors (TDI, MDI, Polyols) APME technical report June 1996 -- Data documented by: Sophie Louis, Volvo Technical Development Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	APME's eco-profiles serve two
General Purpose	There is an increasing demand concerning LCA data. Following this trend, ISOPA [The European Isocyanate Producers Association] members in Western Europe wanted to provide public ''Cradle to the gate data'' concerning their product's life-cycle.
Detailed Purpose	The aim here is to provide ''cradle to gate'' data for the manufacturing of TDI
Commissioner	- ISOPA, Avenue E. van Nieuwenhuyse 4 Box 2 B 1160 Brussels.
Practitioner	Boustead, Ian Dr - .
Reviewer	
Applicability	
About Data	The transport of the different precursors to the plant where is produced polyurethane foam is not included here in this set of data. Data on the production processes have been supplied by ARCO Chemical, BASF, BAYER, DOW, Enichem, ICI, Rhone Poulenc and Shell relating to plants operating in Belgium, France Germany, Italy, the Netherlands, Portugal, Spain and the United Kingdom. Data have been obtained from plants in 1990 produced some 250000 tonnes of TDI. It is important to recognise that the data do not refer only to the final conversion stages leading to TDI but to all operations starting with raw materials in the earth-
Notes	

SPINE LCI dataset: Thermal treatment of solid municipal waste

Administrative	
Finished	Y
Date Completed	2002-08-14
Copyright	McDougall F. et al, Integrated Solid Waste Management
Availability	Public

Technical System	
Name	Thermal treatment of solid municipal waste
Functional Unit	1 tonne of waste to incineration
Functional Unit Explanation	An average composition of Municipal solid waste is used here. The waste to incineration have the following compostion: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic is used. (McDougall F.)
Process Type	Gate to gate
Site	Europe
Sector	Waste treatment
Owner	Europe
Technical system description	Thermal treatment of municipal solid waste is an incineration process where outputs of the process depend on the inputs, e.g. what is burned. - The process: This activity describes a mass-burn process for mixed municipal solid waste (MSW). Mixed MSW contains; paper, film plastic, rigid plastic, glass, textile, ferrous material, non-ferrous material, organics and other. The thermal treatment process, as well as liberating energy from the incoming waste, also consumes energy. This is required for operating cranes, moving grates or fluidised bed, fans for air, injectors, and emission control equipment, as well as for general heating and lighting. For Municipal solid waste incineration around 14% of the electrical power generated is consumed on-site with a specific consumption of around 70kWh/tonne incinerated (McDougall, 2001) Therefore only Natural gas is added to the process as an inflow of energy. It is assumed that recovered energy is used only to generate electricity and that electricity is exported from the system. Since boilers attached to municipal waste incinerators must operate at lower steam temperatures to reduce corrosion, incinerators producing electricity only have a conversion efficiency of around 20%. - Flue gas treatment: There are different types of gas-cleaning processes. The amounts of solid and aqueous waste generated depends on what type of process that is used. A dry-scrubbing system will generate only solid waste whereas a wet-scrubbing system will produce both solid and aqueous waste. Water emissions in this activity arise from use of wet gas-scrubbing equipment. In the model it is assumed that all water emissions are treated on-site, with only resultant sludge (called Slags and ash in the table) leaving the site. Dust from filters and sludge residues from the gas-scrubbing system are also produced. With an air pollution control removal efficiency of about 98.4 % for heavy metals, a small amount of these are emitted to the air. These emissions are presented in the output-table. Heavy metals from incineration are As, Cd, Cr, Cu, Hg, Ni, Pb and Zn. Reference: McDougall F. et al, Integrated Waste Management - a Life Cycle Inventory, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001

System Boundaries	
Nature Boundary	Emissions to air and ground from combustion of different materials in the waste are included. Emissions from natural gas combustion are not included due to lack of data. These emissions are assumed to be a small part of all emissions from the process.
Time Boundary	Study completed 1992-2001
Geographical Boundary	The aim is that the system should represent an incineration plant in Europe.
Other Boundaries	Production of natural gas used in the system is not included.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1992-2001
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	Emission data are from McDougall, 2001 and RTI, 1997. The calculations have been made by the person responsible for this documentation; (Emission factor for each material) * tonne of material incinerated= Emission. The Emission factors are based on a model developed by US EPA, Federal Regulations (RTI, 1997) Data concerning electricity production are taken from ETSU, 1993. Data about Filter dust and Slags and ash are based on a mass-burn facility of Municipal solid waste with a Wet gas-scrubbing process according to McDougall, 2001.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997 Svedberg, Waste Incineration for Energ Recovery, Final report, 1992 ETSU, An Assessment of Mass Burn Incineration Costs, Energy Technology Support Unit, Report B.1314 by Aspinwall and co LTd, London department of trade and company, 1993.
Notes	-

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: An average figure of 0.23 m3/tonne waste incinerated is used (ETSU, 1993). Literature: ETSU, An Assessment of Mass Burn, Incineration Costs Energy Technology Support Quit, Report B.1314 by Aspinwall and company LTd, London department of trade and company, 1993.	Input	Refined resource	Natural gas	0.23			m3	Technosphere	
Method: Waste to incineration with a composition of waste to incineration is 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic is used. That is an average composition of Municipal solid waste. (McDougall, 2001) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001	Input	Refined resource	Waste to incineration	1			tonne	Technosphere	
Method: Based on the composition of the incinerated waste, emissions of heavy metals for each compound have been calculated. The composition used is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Uncontrolled emission factor for each material) * tonne of material incinerated= Uncontrolled emission Air pollution control removal efficency of 99.9% were used for As. (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	As	1.11			mg	Air	
Method: Based on the composition of the incinerated waste, emissions of heavy metals for each compound have been calculated. The composition used is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Uncontrolled emission factor for each material) * tonne of material incinerated= Uncontrolled emission Air pollution control removal efficency of 99.7% were used for Cd. (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	Cd	4.86			mg	Air	

Method: Based on the composition of the incinerated waste emissions of each compound have been calculated. The composition is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Emission factor for each material) * tonne of material incinerated= Emission The emission factors are based on a model developed by the US EPA, Federal Regulations (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	CO	0.6071			kg	Air	
Method: The composition of the waste is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) Based on the composition of the incinerated waste emissions of each compound have been calculated: (Emission factor for each material) * tonne of material incinerated= Emission The emission factors are based on a model developed by the US EPA, Federal Regulations (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	CO2	1115.55			kg	Air	
Method: Based on the composition of the incinerated waste, emissions of heavy metals for each compound have been calculated. The composition used is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Uncontrolled emission factor for each material) * tonne of material incinerated= Uncontrolled emission Air pollution control removal efficency of 99.3% were used for Cr. (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	Cr	6.36			mg	Air	
Method: Based on the composition of the incinerated waste, emissions of heavy metals for each compound have been calculated. The composition used is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Uncontrolled emission factor for each material) * tonne of material incinerated= Uncontrolled emission Air pollution control removal efficency of 99.6% were used for Cu. (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	Cu	37			mg	Air	
Method: Based on the composition of the incinerated waste emissions of each compound have been calculated. The composition is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Emission factor for each material) * tonne of material incinerated= Emission The emission	Output	Emission	Dioxin	6.30E-08			kg	Air	

factors are based on a model developed by the US EPA, Federal Regulations (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997									
Method: Based on the composition of the incinerated waste emissions of each compound have been calculated. The composition is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Emission factor for each material) * tonne of material incinerated= Emission The emission factors are based on a model developed by the US EPA, Federal Regulations (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	HCl	0.198			kg	Air	
Method: Based on the composition of the incinerated waste, emissions of heavy metals for each compound have been calculated. The composition used is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Uncontrolled emission factor for each material) * tonne of material incinerated= Uncontrolled emission Air pollution control removal efficency of 92.7% were used for Hg. (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	Hg	47			mg	Air	
Method: Based on the composition of the incinerated waste, emissions of heavy metals for each compound have been calculated. The composition used is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Uncontrolled emission factor for each material) * tonne of material incinerated= Uncontrolled emission Air pollution control removal efficency of 96.6% were used for Ni. (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	Ni	16.26			mg	Air	
Method: The composition of the waste is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) Based on the composition of the incinerated waste emissions of each compound have been calculated: (Emission factor for each material) * tonne of material incinerated= Emission The emission factors are based on a model developed by the US EPA, Federal Regulations (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies,	Output	Emission	NOx	0.976			kg	Air	

1997									
Method: The composition of the waste is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) Based on the composition of the incinerated waste emissions of each compound have been calculated: (Emission factor for each material) * tonne of material incinerated= Emission The emission factors are based on a model developed by the US EPA, Federal Regulations (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	Particles	0.1146			kg	Air	
Method: Based on the composition of the incinerated waste, emissions of heavy metals for each compound have been calculated. The composition used is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Uncontrolled emission factor for each material) * tonne of material incinerated= Uncontrolled emission Air pollution control removal efficency of 99.8% were used for Pb. (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	Pb	19.31			mg	Air	
Method: The composition of the waste is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. Based on the composition of the incinerated waste emissions of each compound have been calculated: (Emission factor for each material) * tonne of material incinerated= Emission The emission factors are based upon US EPA, Federal Regulations.(RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	SO2	0.416			kg	Air	
Method: Based on the composition of the incinerated waste, emissions of heavy metals for each compound have been calculated. The composition used is: 15% paper, 15% other, 10% organic, 10% film plastic, 10% ferrous material, 10% non-ferrous, 10% textile, 10% glass and 10% rigid plastic. (McDougall, 2001) (Uncontrolled emission factor for each material) * tonne of material incinerated= Uncontrolled emission Air pollution control removal efficency of 99.7% were used for Zn. (RTI, 1997) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997	Output	Emission	Zn	712.60			mg	Air	
Method: Energy production is based on mass burn of Municipal solid waste (MSW). In Sweden the calorific value is 7-11GJ/tonne incinerated (Svedberg, 1992). Energy Technology Support Unit (ETSU, 1993) for this model assume a gross production of 520 kWh/tonne of waste with a net calorific value of 8.0 GJ/tonne (McDougall, 2001). Incinerators producing electricity only have a	Output	Refined resource	Electricity	450			kWh	Technosphere	

conversion efficiency of 20% beacause boilers attached to municipal waste incinerators must operate at lower steam temperatures to reduce corrosion. For MSW incineration around 14% of the electrical power generated is consumed on-site with a specific consumption of around 70kWh/tonne incinerated (McDougall, 2001) This gives an electricity stream out of the system of 520-70= 450kWh/tonne waste to incineration Literature: Svedberg, Waste Incineration for Energ Recovery, Final report, 1992 ETSU, An Assessment of Mass Burn Incineration Costs, Energy Technology Support Unit, Report B.1314 by Aspinwall and co LTd, London departmant of trade and company, 1993. Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Notes: For Residue Derived Fuel(RDF) a calorific value of 18GJ/tonne can be assumed (McDougall, 2001)									
Method: For mass-burn of MSW a wet gas-scrubbing process result in 20-30 kg of dust/tonne waste. (McDougall, 2001) Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001	Output	Residue	Filter dust	20			kg	Ground	
Method: For mass-burn of MSW a wet gas-scrubbing process result in 2.5-12 kg of sludge residue per tonne waste incinerated (McDougall, 2001) In this model this sludge is called Slags and ash even though ash is not produced. Literature: Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001	Output	Residue	Slags and ash	12			kg	Technosphere	

About Inventory

Publication	McDougall F. et al, Integrated Solid Waste Management - A Life Cycle Inventory, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 Data documented by: Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Documentation reviewed by: Ann-Christin Pålsson, Industrial Environmental Informatics, Chalmers University of Technology Published in SPINE@CPM: 14 August 2002
Intended User	The original study this docume
General Purpose	Data about waste management systems are insufficient and more data are required by the industry.
Detailed Purpose	This documentation is based on a study about Integrated Solid Waste Management performed by Forbes McDougall et al at Procter & Gamble Technical Centres, 2001. The aims of that study was to introduce a LCI model for Integrated Waste Management and to provide data that support the concept of Integrated Waste Management as a sustainable method of managing solid waste. The purpose of the documentation of this system has been to make data for waste management available in this format for the industry.
Commissioner	
Practitioner	
Reviewer	
Applicability	Most incinerators are mass-burn facilities, with an input of mixed municipal solid waste (MSW) but the input to a thermal system could also be Refuse-derived Fuel (RDF) or source-separated paper and plastic depending on the process involved. RDF is lighter materials in MSW (paper and plastic), which are separated out and shredded to produce ''floc'' or non-densified RDF (cRDF). This can then be pelletized to improve handling, producing densified RDF (dRDF). Burning RDF or paper and plastic as fuels involves a relatively consistent and well-defined input of waste. The inputs to MSW incinerators, comprising of restwaste and residues from other waste treatment processes, is much more variable. This incoming waste will vary with the waste composition, which has been shown to vary both geographical and seasonally. Flue gas cleaning processes are becoming more effective and air emissions are different at different plants. Therefore less or more inorganic pollutants can be emitted to the atmosphere. For air emissions from combustion of MSW there is an EU Directive and the maximal

	emission level for each compound within EU is presented below: Particles 150, CO 500, SOx 1500, HCl 250, HF 100, Total HC 100, Cd 0.5 g/tonne burned material. (89/369/EEC(1989) Emissions from the system described here are all below the maximum emission levels within EU. Energy production in this system is calculated for mass burn of MSW in Sweden. The calorific value for MSW in Sweden is 7-11 GJ/tonne (Svedberg, 1992) and the calorific value for RDF in Sweden can be assumed to be 11-18 GJ/tonne (Svedberg, 1992) For PPDF i.e. burning of source-separated paper and plastic as fuel, data are insufficient. Not all of the primary heat released in an incinerator can be recovered in a useful form, and the level of recovery depends on the use to which the energy is put. Since boilers attached to municipal waste incinerators must operate at lower steam temperatures to reduce corrosion, incinerators producing electricity only have a conversion efficiency of around 20%. With a gross power production of 520 kWh/ tonne of waste (Atkins, 1993) with a net calorific value of 8.0 GJ/tonne, giving a conversion efficiency of 23% for a plant of 200 000 tonnes per year capacity. Energy released during incineration may be used for several purposes, e.g. electricity generation, heat and steam production, each with its own conversion rate for the amount of useful energy produced. References: Svedberg G, Waste Incineration For Energy Recovery, Final Report, 1992. Atkins et al, Energy Technology Support Unit, An assessment of mass-burn incineration costs, 1993
About Data	Data gives a rough picture of in and outputs from a thermal treatment plant in Europe. Data are based on the study about Integrated Solid Waste Management performed by Forbes McDougall et al at Procter & Gamble Technical Centres, 2001. The descriptions of the activity is how it was understood by the person who made the documentation. It needs to be borne in mind that not all emission data sets are complete, and that incineration of mixtures may not give rise to the sum of their parts, since interactions may occur. Emission for natural gas used in the system are not accounted for. Emissions from different materials in the waste are accounted for. The data is only valid for waste with the specific composition used in this system, see functional unit explanation for further information. Data for different compositions can be found in McDougall F., Integrated Solid Waste Management. Wet gas-scrubbing results in 20-30 kg of dust and 2.5-12 kg sludge residue per tonne of municipal solid waste incinerated. Here it is assumed that 20 kg of dust and 12 kg of sludge residues from the gas-scrubbing system are produced. A small amount of heavy metals are emitted, about 98.4 % of these air pollutions are taken care of by the air pollution control in the flue gas treatment. Heavy metals from incineration are As, Cd, Cr, Cu, Hg, Ni, Pb and Zn.
Notes	For further information about solid waste managment see: Flemström K., Brief overview of solid waste management, IMI-internal report. The report may be downloaded from: http://www.imi.chalmers.se

SPINE LCI dataset: Thinning of forest area

Administrative	
Finished	Y
Date Completed	1994-02-24
Copyright	None
Availability	Public

Technical System	
Name	Thinning of forest area
Functional Unit	ha
Functional Unit Explanation	Per hectare forest area
Process Type	Gate to gate
Site	Middle Sweden
Sector	Forestry
Owner	Middle Sweden

Technical system description	Thinning is performed in order to increase the productivity of the remaining forest. The thinning is conducted using forest processors. Light processors avoid damages to tree roots.

System Boundaries

Nature Boundary	Emissions caused by combustion of fuels is not included.
Time Boundary	The data collected are representative for the time period 1992-1994.
Geographical Boundary	Central Sweden.
Other Boundaries	N/A
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1994-02-24
Data Type	Unspecified, expert outspoke
Represents	See 'Function'.
Method	Information supplied by Stellan Jägermyr, Sjögränds plantskola, Hagfors. For more information see specific QMetaData for each flow.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997 Svedberg, Waste Incineration for Energ Recovery, Final report, 1992 ETSU, An Assessment of Mass Burn Incineration Costs, Energy Technology Support Unit, Report B.1314 by Aspinwall and co LTd, London departmant of trade and company, 1993.
Notes	-

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: 1,6 l diesel/m3sub (plus 6% extra) covers the two rounds of thinning. Assuming 35,6 MJ/l and a productivity of 400 m3sub/ha leaves 24151 MJ/ha.	Input	Refined resource	Diesel	24151			MJ	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Fertilized forest area is derived in the proceeding step: Fertilizing in silviculture.	Input	Refined resource	Fertilized forest area	1			ha	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke	Output	Product	Thinned forest area	1			ha	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: According to Skogforsk 100 of the total 400 m3sub/ha are taken out during thinning. Of these 90% are used for pulping and 10% for sawmills.	Output	Product	Thinning softwood	100			m3 fub	Technosphere	Sweden
	Output	Product	Unspecified	1			m3 fub	Technosphere	Sweden

About Inventory

Publication	None -- Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose is to supply with LCA-data for forestry to be used in further studies of wood products.
Detailed Purpose	These data are an update of earlier data on the same subject. To be used in LCA representing the thinning part of forestry in central Sweden. Can also be used as an average for Sweden.
Commissioner	- Stora Corporate Research, Box 601 661 29 Säffle Sweden.
Practitioner	Swan, Göran - Stora Corporate Research, Box 601, S-661 29 Säffle, Sweden.
Reviewer	Hallonborg, Ulf - Skogforsk

Applicability	These data are valid for large scale thinning in forestry. It is important to check the type of fuel used. In this case, fossil fuel is assumed to be used. Other data is available from other forest companies, or from Skogforsk, or STFI. The silviculture process in Sweden has eight steps: 1. Plant nursing 2. Soil preparation 3. Planting 4. Clearing 5. Thinning 6. Fertilizing 7. Final felling 8. Forwarding to roadside This is the first step.
About Data	N/A
Notes	N/A

SPINE LCI dataset: Transistor assembly

Administrative	
Finished	Y
Date Completed	2000-02-28
Copyright	Ericsson
Availability	Official

Technical System	
Name	Transistor assembly
Functional Unit	One gram of transistor capsule.
Functional Unit Explanation	The motivation for choosing this functional unit is: · suitable unit to work with in an LCA of a private branch exchange (a complicated telecom product) · important component of the MD110 product system and many other electronic products. DESIGN The answers from the component manufacturer are for a transistor. These facts are based on Ericsson technical specification of the component. Ericsson product number: RYN 121 37/1 Ericsson description: Transistor, Silicon General information NPN planar epitaxial low level amplifier and switching transistor in plastic case intended for surface mounting. Dimensions: moulded plastic case, SOT-23 Weight: about 0.017 grams Height: 0.85-1.21 mm Width: 2.8-3.0 mm Length: 1.2 - 1.4 mm Leads diameter: 0.08-0.15 mm Leads width: 0.38-0.48 mm
Process Type	Gate to gate
Site	Not relevant
Sector	Manufacturing
Owner	Not relevant
Technical system description	This activity includes the final assembly of a transistor. The activity is based on information acquired from one manufacturer. The description of the process is supplied by this manufacturer, but is assumed to be general for this type of manufacture. The following process steps are included; 1. Si-crystal die bonding onto a leadframe 2. Wire bonding 3. Encapsulation, usually in an epoxy plastic

	4. Solder- or tinplating 5. Trim, form and mark 6. Testing and packing No detailed description was given by the manufacturer.

System Boundaries

Nature Boundary	The emissons to air and water have nature as recipient. Each parameter mentioned by the component manufacturer have been studied. No parameter has deliberately been disregarded when environmental impact have been studied.
Time Boundary	1997 The answer from the manufacturer arrived in 1998 and they measured in 1997. The process technology used is most certainly the best available as the factory is located in Hong Kong and the company is well established.
Geographical Boundary	The technical system for this model is limited to the factory where the production takes place. The manufacturer is located in Hong Kong.
Other Boundaries	Delimitations to the system is the final step in the making of the transistor. The production of the subparts (e.g. encapsulation, lead frame and bondwires) of the resistor is not included in this model. Also, the Si wafer production and Si wafer processing are excluded. These production steps have instead been treated as a separate activity (see activity ''Si wafer production and Si wafer processing for transistors''). The transportation of them to the factory is not included.
Allocations	The manufacturers have not described how the allocation has been made. We did not decide or have any suggestions on how the manufacturer should allocate in their factory. According to the manufacturer, the data has been obtained by plant expert.
Systems Expansions	None.

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	We asked three manufacturers for a transistor with capsule size SOT23. This model describe the assembly/encapsulation to the semiconductor (SOT23) device and not Si wafer production and Si wafer processing. The model shall be regardad as one of two connected models describing three main steps in the manufacturing of a transistor. We got one usable answer, here refered to as CM, and the data that are presented are based on information this component manufacturer. The information was requested using a LCI data questionnaire. However, the manufacturer instead sent a broschure contaning the requested information. The data presented here are based on this broschure.
Literature Reference	Integrated Waste Management - a Life Cycle Inventory, F. McDougall et al, Procter & Gamble Technical Centres Limited, Blackwell Science, 2001 RTI, Research Triangle Institute, Application of Life Cycle Management To Evaluate Integrated Municipal Waste Strategies, 1997 Svedberg, Waste Incineration for Energ Recovery, Final report, 1992 ETSU, An Assessment of Mass Burn Incineration Costs, Energy Technology Support Unit, Report B.1314 by Aspinwall and co LTd, London departmant of trade and company, 1993.
Notes	-

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0.125 g/g Notes: Packaging material	Input	Refined resource	Al	0.125			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 3.15 mg/g Notes: The gold is used for wire bonding.	Input	Refined resource	Au	0.00315			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 200 Wh/g	Input	Refined resource	Electricity	200			Wh	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 3000 mg/g	Input	Refined resource	Epoxy	3			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 225 mg/g Notes: Specified as cardboard used for packaging.	Input	Refined resource	Kraftliner	0.225			g	Technosphere	

Date concieved: 1997 Data type: Derived, unspecified Method: CM: 2125 mg/g Notes: This lead frame usually consists of a metal alloy based on copper or iron.	Input	Refined resource	Lead frame	2.125			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 8,25 g/g	Input	Refined resource	N2	8.25			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0,375 g/g	Input	Refined resource	Organics	0.375			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0.025 g/g Notes: Packaging material	Input	Refined resource	Polypropylene	0.025			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: One m2 of Si wafer weighs 0.47 kg. The thickness of the wafer is 200e-6 m. This means 1 mm2 Si wafer weighs 0.00047 g 1 g Integrated circuit capsule would then correspond to an input of 2127.7 mm2 Si wafer. This is not an average value and the figure is based only on one answer.	Input	Refined resource	Silicon wafer	2127.7			mm2	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 1000 mg/g	Input	Refined resource	Solder	1			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 7,25 g/g	Input	Refined resource	Water	7.25			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 8,75 mg/g	Output	Emission	Cl, Si, B	0.00875			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 8,25 g/g	Output	Emission	N2	8.25			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 375 mg/g	Output	Emission	Organics	0.375			g	Air	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 250 mg/g	Output	Emission	Solder	0.25			g	Water	
Date concieved: 1997 Data type: Derived, unspecified Method: CM; 7,25 g/g	Output	Emission	Water	7.25			g	Water	
Date concieved: 1998 Data type: Derived, unspecified Method: Transistor capsule = Life Cycle Inventory model for production of one gram of transistor capsule (applicable to telecommunication equipment).	Output	Product	Transistor capsule	1			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 0,125 mg/g	Output	Residue	Al	0.000125			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 12.5 mg/g	Output	Residue	Capsules	0.0125			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 2419.3 mg/g	Output	Residue	Epoxy	2.4193			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 225 mg/g	Output	Residue	Kraftliner	0.225			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 1775 mg/g	Output	Residue	Lead frame	1.775			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 25 mg/g	Output	Residue	Polypropylene	0.025			g	Technosphere	
Date concieved: 1997 Data type: Derived, unspecified Method: CM: 688 mg/g	Output	Residue	Solder	0.688			g	Technosphere	

About Inventory	
Publication	Not available --- Data documented by: Anders Andrae, Ericsson Business Networks AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	The intended use for this LCI

General Purpose	The general purpose with this LCI model was for application in a LCA project at Ericsson Business Networks. The main goal of the study is; to compare the potential environmental impacts associated with an old (BC 8) and a new model (BC 10) of a private branch exchange (PBX) system, namely the MD110 system, and an additional objective is to include comparisons between different stages of the life cycle (e.g. manufacturing, use and end of life) of the system. The system, PBX MD110, is designed, developed and delivered by Ericsson Enterprise Systems AB. Life-Cycle Assessment methodology (following the ISO14040 standards for LCAs) will be used to determine the environmental impacts. The main purpose of the study for Ericsson is; - to learn, test and evaluate the LCA-methodology as a tool for assessing environmental improvement options in the product design process, and to make up concrete product guidelines regarding design for environment (DfE) and - to evaluate environmental aspects in new design. The relative importance for different life cycle stages may also be an important input in the internal work with an Environmental Management System for Ericsson Enterprise Systems. Another purpose of the study is; to collect and qualify data from suppliers and literature in order to build up a database for this and future LCA activities and within the project, it is also intended to analyse the possibilities to use the study as a base for future work regarding a type III ecolabeling project within Ericsson. The intended audience of the report from the project is; Ericsson's personnel: project management, system management, design, marketing and sales organisation, and thus also (in an extracted version) the Ericsson customers.
Detailed Purpose	Map a transistor assembly process from an environmental standpoint in a structured procedure. The purpose of the project was to collect resource consumption data and emission data connected with the final assembly of transistors and resembling components in our telecom products. The usage for this set of data are life cycle assessments where transistors are part of the studied system. Note: This model is one of in total eighteen models compiled at Ericsson, describing 16 component groups in the PBX. The division into component groups is based on structural resemblance, electrical function and material contents of the different components. -- Below is a list of the component groups and corresponding models that have been compiled: 1. Cables - Model: Cable assembly 2. Capacitors and filters; hole mounted devices - Model: Capacitor for hole mounting assembly 3. Capacitors; surface mounted devices - Model: Capacitor for surface mounting assembly 4. Connectors and holders - Model: Connector assembly 5. Diodes - Model: Diode wafer production and assembly 6. Display units and indicators - Model: Liquid crystal display assembly 7. Microcircuits, oscillators, quartz crystal units and delay lines (2 models) - Models: 1. Integrated circuit capsule assembly and 2. Si wafer production and Si wafer processing for integrated circuits (these models are interlinked) 8. Other - Model: ''Other'' electronic component assembly 9. Potentiometers - Model: Potentiometer assembly 10. Printed boards - Model: Printed board assembly 11. Relays - Model: Relay assembly 12. Resistor networks - Model: Resistor network assembly 13. Resistors, varistors and thermistors; hole mounted devices - Model: Resistor for hole mounting assembly 14. Resistors; surface mounted devices - Model: Resistor for surface mounting assembly 15. Transformers and inductors - Model: Inductor assembly 16. Transistors and opto couplers (2 models) - Models: 1. Transistor assembly and 2. Si wafer production and Si wafer processing for transistors (these models are interlinked)
Commissioner	- Ericsson .
Practitioner	Andrae, Anders - Ericsson Business Networks AB Augustendalsvägen 21 S-131 89 Stockholm Office: Nacka Strand .
Reviewer	Pålsson, Ann-Christin - CPM Chalmers University of Technology S-412 96 Göteborg Sweden

Applicability	This set of data can be applied to transistors in electronic equipment if you know how much the transistors weigh. The model is also intended to be representative for opto couplers. This model is one of two connected models describing three main steps in the manufacturing of a transistor. The Si wafer production and Si wafer processing for the transistor is described in a separate model; see the activity ''Si wafer production and Si wafer processing for transistors''.
About Data	The data is based on information from a company confidential brochure. The information was requested using a life cycle inventory questionnaire. The company chose to give us a brochure, instead of filling in our questionnaire but the result would have been the same. The outline of the LCI data questionnaire that were used in the inventory follows below. No limitations or specifications were set for which substances they had to account. -- LCI data questionnaire -- Transport description: Material type, Used weight of Material (g)/functional unit, Transport by road of Material (km), Transport by boat of Material (km), Transport by rail of Material (km). We here only asked for flows exceeded 2% by weight of the material declaration of the component. Additional information was also asked for and here some manufacturers mentioned they had aeroplane transport instead of some of the other transport modes.´ Process description. Description of the entire production at the plant/site and a technical description of the plant production. Description of the production line of the studied product. Flow chart of process steps for production of the studied product. Technical description of the production line. A very short description of each unit operation. Data quality. For every figure you give, give an account on how you gathered it. C = calculated, E = estimated, M = measured. General LCA-related information on the production system (Allocation procedures, system boundaries, etc.). Additional information. (e.g. planned changes in production rate) Material, components and natural resource input, etc. We told them to express data in amount per functional unit. Name of material, component or resource. Used amount(mg). Amount In Product(mg). Additional information Energy-ware input Energy -ware source. Quantity/functional unit. Unit. Energy-ware supplier, production site (address). Suppliers of transport (address). Additional information. Emissions. Emissions to air. Indicate whether emissions from energy use are included in the data. Name of emission to air. Emission to air/functional unit (mg). Additional information. Emissions to water. Indicate if data describes emissions going to external purification plant or directly to recipient. Name of emission to water. Emission to water/functional unit (mg). Additional information. Emissions to soil. Name of emission to soil. Emission to soil/functional unit (mg). Additional information. Waste. Name of waste. Waste/functional unit (mg). Recycled/functional unit (mg). Additional information.
Notes	

SPINE LCI dataset: Transport with a compressed natural gas bus. ESA-DBP

Administrative	
Finished	Y
Date Completed	2002
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Transport with a compressed natural gas bus. ESA-DBP

Functional Unit	1 bus km
Functional Unit Explanation	The bus runs in Braunschweig driving cycle (see also 'Function').
Process Type	Gate to gate
Site	Unknown
Sector	Transport
Owner	Unknown
Technical system description	The compressed natural gas bus is a quite popular mode of transport. It uses specially prepared natural gas - CNG-b. (Excerpt from the report, see 'Publication'): ''The emission data and energy used for several bus technologies have been measured at the test facilities of the Swedish Motor Vehicle Inspection Co. The Braunschweig driving cycle is used. The test inertia used for the buses was 13 ton.'' (NB: The Braunshweig driving cycle covers: duration - 1740 s, average speed - 22.9 km/h, maximum speed - 58.2 km/h, idling time 22 %, driving distance - 11km). This process is included in the system described in: Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf Other processes in the CPM Database also included in the above publication: Hydrogen fuel production by steam reforming of natural gas. ESA-DBP Hydrogen fuel production from on-site electrolysis. ESA-DBP Transport with a fuel cell bus run on hydrogen produced in steam reforming process. ESA-DBP Transport with fuel cell bus run on hydrogen produced in electrolysis process. ESA-DBP Transport with a diesel bus. ESA-DBP

System Boundaries

Nature Boundary	In the process there are included inflows and outflows from two different activities. One of them is natural gas production (Well-to-Tank), which includes all life cycle process in the fuel pathway, from feedstock to fuel dispenser nozzle. The other one is using the bus (Tank-to-wheel) which relates to ''moving of vehicle through its driving cycle''.
Time Boundary	The data come from the year 2000.
Geographical Boundary	The buses were tested in the test facilities of the Swedish Motor Vehicle Inspection Co. (Sweden)
Other Boundaries	The Braunschweig driving cycle is used. (NB: The Braunshweig driving cycle covers: duration - 1740 s, average speed - 22.9 km/h, maximum speed - 58.2 km/h, idling time 22 %, driving distance - 11km). The fuel is compressed natural gas - CNG-b.
Allocations	Data were given for 1 bus km.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2000
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from other report
Literature Reference	http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2002--10.pdf These specific data come from: Ahlvik, P. and Brandberg, Å. (2000). Relative Impact on Environment and Health from the Introduction of Low Emission City Buses in Sweden. In Proceedings International Spring Fuels & Lubricants Meeting & Exposition, Paris
Notes	-

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Natural resource	Natural gas	2.46E+01			MJ	Ground	
	Output	Emission	CH4	2.68E+00			g	Air	Sweden
	Output	Emission	Fossil CO2	1.44E+03			g	Air	Sweden
	Output	Emission	N2O	1.20E-03			g	Air	Sweden
	Output	Emission	NOx	3.01E+00			g	Air	Sweden
	Output	Emission	Particles	1.50E-02			g	Air	Sweden

About Inventory

Publication	Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf

Intended User	LCA practitioner
General Purpose	Excerpt from the report, see ' Publication': ''The main goal is an environmental assessment of the use of fuel cell buses on bus route 60 in Göteborg. Environmental assessments involve the gathering, evaluation and synthesize of data and methods using engineering and scientific research to help address an environmental decision making situation. This assessment is made to decide whether to invest in a new technology for fuel cell buses by 2006 or to rely on other bus technologies. (...) The main goal is divided into 3 parts. the first goal of this study is to describe the technical system, methodology used, and frame of the problem. In the future when real investment decision will be made, this study could then help frame an actual investment decision. The second goal is to present environmental performance results for the different alternative bus technologies. The results address emissions, health effects, and financial investments. The third goal is to describe and assess the uncertainties of the results.
Detailed Purpose	A transport with a compressed natural gas bus was compared to the transport with the fuel cell bus which was a main object of the study.
Commissioner	MISTRA - .
Practitioner	Karlström, Magnus - .
Reviewer	Steen, Bengt -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The results from compressed natural gas bus tests were compared to diesel bus and fuel cell bus which can also be found in CPM.

SPINE LCI dataset: Transport with a diesel bus. ESA-DBP

Administrative	
Finished	Y
Date Completed	2002
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Transport with a diesel bus. ESA-DBP
Functional Unit	1 bus km
Functional Unit Explanation	The bus runs in Braunschweig driving cycle (see also 'Function').
Process Type	Gate to gate
Site	Unknown
Sector	Transport
Owner	Unknown
Technical system description	The diesel bus is a one of the most popular modes of public transport. The particular one runs on special kind of diesel fuel AdvDie. (Excerpt from the report, see 'Publication'): ''The emission data and energy used for several bus technologies have been measured at the test facilities of the Swedish Motor Vehicle Inspection Co. The Braunschweig driving cycle is used. The test inertia used for the buses was 13 ton.'' (NB: The Braunshweig driving cycle covers: duration - 1740 s, average speed - 22.9 km/h, maximum speed - 58.2 km/h, idling time 22 %, driving distance - 11km). This process is included in the system described in: Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf

	Other processes in the CPM Database also included in the above publication: Hydrogen fuel production by steam reforming of natural gas. ESA-DBP Hydrogen fuel production from on-site electrolysis. ESA-DBP Transport with a fuel cell bus run on hydrogen produced in steam reforming process. ESA-DBP Transport with fuel cell bus run on hydrogen produced in electrolysis process. ESA-DBP Transport with a compressed natural gas bus. ESA-DBP

System Boundaries

Nature Boundary	In the process there are included inflows and outflows from two different activities. One of them is diesel production (Well-to-Tank), which includes all life cycle process in the fuel pathway, from feedstock to fuel dispenser nozzle. The other one is using the bus (Tank-to-wheel) which relates to ''moving of vehicle through its driving cycle''.
Time Boundary	The data come from the year 2000.
Geographical Boundary	The buses were tested in the test facilities of the Swedish Motor Vehicle Inspection Co. (Sweden)
Other Boundaries	The Braunschweig driving cycle is used. (NB: The Braunshweig driving cycle covers: duration - 1740 s, average speed - 22.9 km/h, maximum speed - 58.2 km/h, idling time 22 %, driving distance - 11km). The tests were done for a diesel AdvDie fuel.
Allocations	Data were given for 1 bus km.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2000
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from other report
Literature Reference	http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2002--10.pdf
Notes	-

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Oil	1.87E+01			MJ	Technosphere	
	Output	Emission	CH4	3.50E-02			g	Air	
	Output	Emission	Fossil CO2	1.25E+03			g	Air	
	Output	Emission	N2O	2.30E-03			g	Air	
	Output	Emission	NOx	6.12E+00			g	Air	
	Output	Emission	Particles	3.14E-02			g	Air	

About Inventory

Publication	Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see ' Publication': ''The main goal is an environmental assessment of the use of fuel cell buses on bus route 60 in Göteborg. Environmental assessments involve the gathering, evaluation and synthesize of data and methods using engineering and scientific research to help address an environmental decision making situation. This assessment is made to decide whether to invest in a new technology for fuel cell buses by 2006 or to rely on other bus technologies. (...) The main goal is divided into 3 parts. the first goal of this study is to describe the technical system, methodology used, and frame of the problem. In the future when real investment decision will be made, this study could then help frame an actual investment decision. The second goal is to present environmental performance results for the different alternative bus technologies. The results address emissions, health effects, and financial investments. The third goal is to describe and assess the uncertainties of the results.
Detailed Purpose	A transport with a bus run on diesel was compared to the transport with the fuel cell bus which was a main object of the study.
Commissioner	MISTRA - .
Practitioner	Karlström, Magnus - .
Reviewer	Steen, Bengt -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet)

	Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the reference report there is also information about other kind of diesel fuel - DME. The results from this study were not implemented into the database due to small differences between them.

SPINE LCI dataset: Transport with a fuel cell bus run on hydrogen produced in electrolysis process. ESA-DBP

Administrative	
Finished	Y
Date Completed	2002
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Transport with a fuel cell bus run on hydrogen produced in electrolysis process. ESA-DBP
Functional Unit	1 bus km
Functional Unit Explanation	The flow data are given per 1 km which the fuel cell bus will run. The bus weighs 18900 kg.
Process Type	Gate to gate
Site	Volvo, Sweden
Sector	Transport
Owner	Volvo, Sweden
Technical system description	The fuel cell buses can run using hydrogen as a fuel. For this study simulation from Volvo was used as a reference. In the study it was assumed that the route of the bus includes (excerpt from the report, see 'Publiation'): ''starting capability on a steep slope, acceleration, maximum speed and uphill speed holding at normal speed. The fuel cell bus powertrain used has a minimum battery and hydrogen storage and no reformer. The weight of the fuel cell bus is 18,900 kg and the nominal power of the electrical machine is 250kW.'' This process is included in the system described in: Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf Other processes in the CPM Database also included in the above publication: Hydrogen fuel production by steam reforming of natural gas. ESA-DBP Hydrogen fuel production from on-site electrolysis. ESA-DBP Fuel cell bus run on hydrogen produced in steam reforming process. ESA-DBP

System Boundaries	
Nature Boundary	In the process there are included inflows and outflows from two different activities. One of them is hydrogen production (Well-to-Tank), which includes all life cycle process in the fuel pathway, from feedstock to fuel dispenser nozzle. The other one is using the bus (Tank-to-wheel) which relates to ''moving of vehicle through its driving cycle The bus is used in the following conditions (excerpt from the report, see 'Publication'): ''starting capability on a steep slope, acceleration, maximum speed and uphill speed holding at normal speed.''
Time Boundary	The data were acquired in 2002 as the most up-to-date ones.
Geographical Boundary	The study was performed for Sweden.
Other Boundaries	The particular fuel cell bus runs on the hydrogen produced in electrolysis process.
Allocations	Data are given per 1 bus km.
Systems Expansions	Not applicable.

Flow Data
General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Interview
Literature Reference	Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2002--10.pdf The reference for specific inventory data for the process (hydrogen production): Röder, A. (2001). Life Cycle Inventory and Costs of Different Car Powertrains. Villingen The reference for specific inventory data for the process (fuel cell bus running): Interview with Lars Calhammar Volvo Technical Development
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Hydro energy	7.74E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Nuclear	2.92E+00			g	Technosphere	Sweden
	Input	Refined resource	Oil	3.30E-01			MJ	Technosphere	
	Input	Resource	Biomass	1.55E+00			MJ	Technosphere	Sweden
	Input	Resource	Natural gas	1.00E-02			MJ	Ground	
	Output	Emission	Fossil CO2	1.31E+02			g	Air	Sweden
	Output	Emission	NOx	1.70E-01			g	Air	Sweden
	Output	Emission	Particles	2.98E-02			g	Air	Sweden

About Inventory

Publication	Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report (see 'Publication'): ''The main goal is an environmental assessment of the use of fuel cell buses on bus route 60 in Göteborg. Environmental assessments involve the gathering, evaluation and synthesize of data and methods using engineering and scientific research to help address an environmental decision making situation. This assessment is made to decide whether to invest in a new technology for fuel cell buses by 2006 or to rely on other bus technologies. (...) The main goal is divided into 3 parts. the first goal of this study is to describe the technical system, methodology used, and frame of the problem. In the future when real investment decision will be made, this study could then help frame an actual investment decision. The second goal is to present environmental performance results for the different alternative bus technologies. The results address emissions, health effects, and financial investments. The third goal is to describe and assess the uncertainties of the results.''
Detailed Purpose	Fuel cell bus is an object of the study. Therefore the environmental impact of it was investigated and the result compared to the other types of buses (e.g. run on diesel).
Commissioner	MISTRA - .
Practitioner	Karlström, Magnus - .
Reviewer	Steen, Bengt -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, the Division of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study the performance of fuel cell bus was compared to other buses for example: fuel cell run on hydrogen produced by steam reforming process, diesel and run on methane.

SPINE LCI dataset: Transport with a fuel cell bus run on hydrogen produced in steam reforming process. ESA-DBP

Administrative

Finished	Y

Date Completed	2002
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Transport with a fuel cell bus run on hydrogen produced in steam reforming process. ESA-DBP
Functional Unit	1 bus km
Functional Unit Explanation	The flow data are given per 1 km which the fuel cell bus will run.
Process Type	Gate to gate
Site	Volvo, Sweden
Sector	Transport
Owner	Volvo, Sweden
Technical system description	The fuel cell buses can run using hydrogen as a fuel. For this study simulation from Volvo was used as a reference. In the project it was assumed that the route of the bus includes (excerpt from the report see 'Publication'): ''starting capability on a steep slope, acceleration, maximum speed and uphill speed holding at normal speed. The fuel cell bus powertrain has a minimum battery and hydrogen storage and no reformer. The weight of the fuel cell bus is 18,900 kg and the nominal power of the electrical machine is 250kW. '' The hydrogen used for the fuel cell bus was produced in a steam reforming process. This process is included in the system described in: Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf Other processes in the CPM Database also included in the above publication: Hydrogen fuel production by steam reforming of natural gas. ESA-DBP Hydrogen fuel production from on-site electrolysis. ESA-DBP Fuel cell bus run on hydrogen produced in electrolysis process. ESA-DBP

System Boundaries

Nature Boundary	In the process there are included inflows and outflows from two different activities. One of them is hydrogen production (Well-to-Tank), which includes all life cycle process in the fuel pathway, from feedstock to fuel dispenser nozzle. The other one is using the bus (Tank-to-wheel) which relates to ''moving of vehicle through its driving cycle''.
Time Boundary	The data were acquired in 2002 as the most up-to-date ones.
Geographical Boundary	The study was performed for Sweden.
Other Boundaries	The bus is used in the following conditions: (excerpt from the report, see 'Publication') ''starting capability on a steep slope, acceleration, maximum speed and uphill speed holding at normal speed.'' The particular fuel cell bus runs on the hydrogen produced in steam reformer process of natural gas.
Allocations	Data are given for 1 bus km.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Unspecified, expert outspoke
Represents	See 'Function'
Method	Interview
Literature Reference	Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2002--10.pdf The reference for specific inventory data for this process: Lars Calhammar, Volvo Technical Development
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Resource	Natural gas	1.59E+01			MJ	Ground	

	Output	Emission	CH4	1.78E-01			g	Air	Sweden
	Output	Emission	Fossil CO2	8.89E+02			g	Air	Sweden
	Output	Emission	N2O	7.10E-03			g	Air	Sweden
	Output	Emission	NOx	3.20E-01			g	Air	Sweden
	Output	Emission	Particles	1.01E-02			g	Air	Sweden

About Inventory	
Publication	Karlström M. (2002). Environmental Technology Assessment of Introducing Fuel Cell City Buses - A Case Study of Fuel Cell Buses in Göteborg. ESA report 2002:10, ISSN:1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2002--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report (see 'Publication'): ''The main goal is an environmental assessment of the use of fuel cell buses on bus route 60 in Göteborg. Environmental assessments involve the gathering, evaluation and synthesize of data and methods using engineering and scientific research to help address an environmental decision making situation. This assessment is made to decide whether to invest in a new technology for fuel cell buses by 2006 or to rely on other bus technologies. (...) The main goal is divided into 3 parts. The first goal of this study is to describe the technical system, methodology used, and frame of the problem. In the future when real investment decision will be made, this study could then help frame an actual investment decision. The second goal is to present environmental performance results for the different alternative bus technologies. The results address emissions, health effects, and financial investments. The third goal is to describe and assess the uncertainties of the results.''
Detailed Purpose	Fuel cell bus is an object of the study. Therefore the environmental impact of it was investigated and the result compared to the other types of buses (e.g. run on diesel).
Commissioner	MISTRA - .
Practitioner	Karlström, Magnus - .
Reviewer	Steen, Bengt -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	____ ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, the Division of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	In the study the performance of fuel cell bus was compared to other buses for example: fuel cell run on hydrogen produced by electrolysis process, diesel and run on methane. Some of them can be found in CPM LCA database.

SPINE LCI dataset: Transportation of crude oil to Sweden

Administrative	
Finished	Y
Date Completed	1996
Copyright	KFB
Availability	Public

Technical System	
Name	Transportation of crude oil to Sweden
Functional Unit	1 MJ
Functional Unit Explanation	The environmental load for transporting 1 MJ crude oil to Sweden
Process Type	Gate to gate
Site	Transportation of crude oil from different parts of the world to Sweden.
Sector	Transport
Owner	Transportation of crude oil from different parts of the world to Sweden.
Technical system description	The system accounts for the transportation of raw oil to Sweden. Also the unloading of the crude oil is accounted for. Crude oil is transported from different parts of the world to refineries in Sweden.

	49% of the total amount crude oil imported to Sweden comes from Norway. All oil coming from Norway is off shore produced crude oil. The rest of the crude oil comes from the following countries in the following amounts: Iran 11%, Lettland 8%, Venezuela 8%, South Arabia 6%, Denmark 6%, Egypt 6%, Nigeria 3% and other countries 3% (According to the Swedish Shipping Association 1996). The crude oil is transported to Sweden by high sea tankers (280 000 ton d.w5) from the Persian golf and Venezuela, ''Norway tankers'' (120 000 ton d.w5) from Norway and coast tankers (20 000 ton d.w5) from the remaining countries.

System Boundaries

Nature Boundary	Emissions to air and energy use are accounted for.
Time Boundary	The data describes the situation for 1996. War, natural disasters, new crude oil findings and such things can change the import situation for Sweden, and therefore the data will get inaccurate.
Geographical Boundary	The world
Other Boundaries	The system accounts for the transportation of 1MJ raw oil to Sweden. Also the unloading of the crude oil is accounted for in the table.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Derived, unspecified
Represents	See 'Function'
Method	literature study of Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5, where the following has been done. The use of energy and emissions due to the transportation is calculated from the total transporting load for the different types of tankers and their routs. The emissions and the energy consumption have been calculated due to the following average distances between the different countries and Sweden: Norway to Sweden 1000 km Back to Norway 1000 km Persian Golf (Abadan) to Sweden 21870 km Back to Persian Golf 13060 Venezuela + Nigeria (Puerto Cabello) to Sweden 8419 km Back to Venezuela + Nigeria 8419 km Latvia to Sweden 400 km Back to Latvia 400 km Denmark + Europe to Sweden 500 km Back to Denmark + Europe 500 km The following emissions are used in the calculations for the different types of boats: Coast tanker: CO2 12,5 g/ tonn and km, CO 0,0187 g/tonn and km, NOx 0,26 g/tonn and km, NMHC 0,0037 g/tonn and km, SO2 0,206 g/tonn and km, Susp solid 0,0075 g/tonn and km. High sea tanker: CO2 3,9 g/ tonn and km, CO 0,0013 g/tonn and km, NOx 0,12 g/tonn and km, NMHC 0,0052 g/tonn and km, SO2 0,097 g/tonn and km, Susp solid 0,0058 g/tonn and km. Norway tanker: CO2 5,5 g/ tonn and km, CO 0,0017 g/tonn and km, NOx 0,15 g/tonn and km, NMHC 0,0066 g/tonn and km, SO2 0,151 g/tonn and km, Susp solid 0,0074 g/tonn and km. The ships are assumed to be carrying full cargo to Sweden and no cargo from Sweden. All figures come from the Swedish Shipping association
Literature Reference	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5.
Notes	The data corresponds to the emissions caused by the transportation of 1 MJ crude oil from different places in the world to Sweden. The energy used in the process is also accounted for.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Diesel	0.0014			MJ	Ground	
	Output	Cargo	Crude oil	1			MJ	Technosphere	Sweden
	Output	Emission	CH4	0.937254			mg	Air	Sweden
	Output	Emission	CO	0.220527			mg	Air	Sweden
	Output	Emission	CO2	586.8995			mg	Air	Sweden
	Output	Emission	NMHC	23.66786			mg	Air	Sweden
	Output	Emission	NOx	16.97916			mg	Air	Sweden
	Output	Emission	SOx	14.59185			mg	Air	Sweden
	Output	Emission	Susp solids	0.84668			mg	Air	Sweden

About Inventory

Publication	Life cycle analysis of fuel, 1996, Blinge Magnus, Aranäs Per-Olof, Bäckström Sebastian, Furnander Åsa, Transportation and logistics, Chalmers University of Technology, KFB-Meddelande1997-5. -- Data documented by: Sara Ågren, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology

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Intended User	Those interested in evaluating
General Purpose	
Detailed Purpose	The data are part of a study concerning alternative fuels
Commissioner	- KFB Komunikations Forsknings Beredningen Box 5706 Linnégatan 2 114 87 Stockholm Sweden.
Practitioner	Blinge Magnus, Arnäs P, Bäckström S, Furnander Å, Hovelius K - Department of Transportation and Logistics Chalmers University of Thechnology.
Reviewer	
Applicability	
About Data	Depending on the type of vehicle that is being used, the chosen route and so on the emissions differ, but no consideration has been made concerning these changes. When working with the report ''Life cycle analysis of fuel'' some errors in the documentation was found. Through a dialog with one of the authors (Blinge Magnus) the matter has been resolved, so that the values and information in SPINE should be correct. In the report, ''Life cycle analysis of fuel'', table 13-4 and B7-4 shows the figures for the environmental load for shipping crude oil to Sweden, when the distance between the Norwegian oil fields and the Swedish refineries has been assumed to be 700 km. The authors of the report thought that this figure was to small and therefore they changed it to 1000 km but not in all the places in the report. In enclosure 3 on line 122 the correct information can be found.
Notes	

SPINE LCI dataset: Transportation with diesel driven waste collection vehicle. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Transportation with diesel driven waste collection vehicle. ESA-DBP
Functional Unit	1 km of transportation
Functional Unit Explanation	1 kilometer of transportation on a typical waste collection route.
Process Type	Unit operation
Site	Gothenburg, Sweden
Sector	Land transport
Owner	Gothenburg, Sweden
Technical system description	Fuel demand and emissions during transportation with a diesel driven waste collection vehicle. Excerpt from the report (for report see link below): ''3.3 Use of the vehicle 3.3.1 Description of a typical waste collection route In the inventory description of the use phase the waste collection route is divided into three ''sub phases'', illustrated in Figure 8. Driving the vehicle from the garage to a waste collection area, between waste collection areas, to the incineration plant and back to the garage is in this report labelled transportation. Within a waste collection area the vehicle drives short distances between sites where waste is collected. This collection area driving is separated from the transportation to and from collection areas because it is another type of driving, generally much slower and with more acceleration and braking, which leads to other exhaust emissions. At the collection stops, waste bins are collected, the waste is loaded into the vehicle and it is then compacted. A conventional vehicle keeps the engine running at the stops, idling when the workers collect waste bins and working when loading and compacting waste. In a hybrid vehicle the engine is turned off 30 seconds after it has stopped, and the electric motor is then used for loading and compacting. Sometimes the loading and compacting procedure is carried through only once at a stop and sometimes a couple of times. After having collected all waste in one collection area, it might continue to another one, located some distance away, such as another city district. When the waste container of

	the vehicle is full, it is taken to the incineration plant, where it is emptied. Then it might go back to the garage or to another waste collection area to continue collecting waste.'' NB: Figure 8 in the text above is figure 8 at page 22 in the report. This process is included in the system described in ''Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	The measurements were made in the year 2004.
Geographical Boundary	The data are results from on board measurements made on a typicla waste collection route on a Volvo diesel waste collection vehicle and a Volvo hybrid waste collection vehicle in Gothenburg, Sweden.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	Excerpt from the report (for report see link in 'LitteratureRef'): ''Emissions and fuel consumption from simulated waste collection have been measured by the consultant firm Ecotraffic ERD3 AB together with Renova (Eriksson et al., 2004). On board measurements on a Volvo diesel vehicle and a Volvo hybrid (both of model FL6E) were used in this study.'' Time measurements, emission calculations and aother considerations when dealing with the fuel consumption simulation can be found in chapter 3.3 in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Average speed is 50 km/h and typical transportation distance is 4.67 km/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Diesel	208			g	Technosphere	
	Output	Emission	CH4	0			g	Air	Sweden
	Output	Emission	CO	2.2			g	Air	Sweden
	Output	Emission	CO2	644			g	Air	Sweden
	Output	Emission	Hydrocarbons	1.9			g	Air	Sweden
	Output	Emission	NOx	5.1			g	Air	Sweden
	Output	Emission	Particles	0.0015			g	Air	Sweden

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Process data in a Master Thesis Report.

Detailed Purpose	This process data set is a part of the comparative LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Renova AB - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpts from the report (for report see link in 'Publication'): ''For evaluation of a gas vehicle, measurements from the hybrid vehicle with the engine kept running at the stops were used. The values were also adjusted according to weight differences due to the extra hybrid electric equipment. The reason for not using data directly from a gas vehicle is because the gas vehicles Renova has is of an older model and have another engine type.'' ''Another important note is that the hybrid vehicle uses a catalytic converter that reduces methane emissions by 80 percent and the diesel vehicle uses a ''CRT particle filter'', which reduces emissions of particles, NOx and CO (Jensen, personal communication). The diesel vehicle fulfils the Euro 3 emission standards.'' ''Measurements were carried out during the different phases related to waste collection. While driving the vehicle at approximately constant speed, 50 km/h, transportation to and from a waste collection area was simulated. Waste collection within a collection area was simulated in a track where driving for 30 seconds followed by a 2 minutes 30 seconds stop for collection, loading and compacting. There are also measurements for idling and loading/compacting separated from the collection track. The measurements for transportation (to and from a collection area) are related to distance and the measurements for collection area driving and collection stop are related to time.'' ''To sum up, the times and distances are: Collection stop time: 1573 seconds/ton Collection area driving time: 503 seconds/ton Transportation distance, conventional vehicle: 4.67 km/ton Transportation distance, hybrid vehicle: 4.77 km/ton'' ''Emissions and resource use during electricity production were calculated using data for average Swedish electricity production (see section 3.1.2).'' NB: Section 3.1.2 is a section in the report. ''Other energy carriers used include diesel, natural gas and fuel oil. Data about production of these were found in a study of production and use of several fuels (Uppenberg et al., 1999). Use of crude oil/natural gas as resource was not included in Uppenberg et al. Instead these resources used were assumed to be of the same amount as the fuel used (1 kg of crude oil for the use of 1 kg of fuel oil or diesel and 1 kg of natural gas for the use of 1 kg of natural gas as fuel). For a few processes, combustion of fuels (fuel oil, diesel and liquefied petroleum gas - LPG) was added using data from the energy and transport database included in LCAiT (CIT Ekologik, 2003). Also data for the production of LPG was taken from this database. Facts from Uppenberg et al. were also used to recalculate fuel amount between units of mass, volume and energy content.'' NB: Complete references to Uppenberg et al. (1999) and CIT Ekologik (2003) can be found in the report. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Transportation with gas driven waste collection vehicle. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology

Availability	Public.

Technical System	
Name	Transportation with gas driven waste collection vehicle. ESA-DBP
Functional Unit	1 km of transportation
Functional Unit Explanation	1 kilometer of transportation on a typical waste collection route.
Process Type	Unit operation
Site	Gothenburg, Sweden
Sector	Land transport
Owner	Gothenburg, Sweden
Technical system description	Fuel demand and emissions during transportation with a gas driven waste collection vehicle. Excerpt from the report (for report see link below): ''3.3 Use of the vehicle 3.3.1 Description of a typical waste collection route In the inventory description of the use phase the waste collection route is divided into three ''sub phases'', illustrated in Figure 8. Driving the vehicle from the garage to a waste collection area, between waste collection areas, to the incineration plant and back to the garage is in this report labelled transportation. Within a waste collection area the vehicle drives short distances between sites where waste is collected. This collection area driving is separated from the transportation to and from collection areas because it is another type of driving, generally much slower and with more acceleration and braking, which leads to other exhaust emissions. At the collection stops, waste bins are collected, the waste is loaded into the vehicle and it is then compacted. A conventional vehicle keeps the engine running at the stops, idling when the workers collect waste bins and working when loading and compacting waste. In a hybrid vehicle the engine is turned off 30 seconds after it has stopped, and the electric motor is then used for loading and compacting. Sometimes the loading and compacting procedure is carried through only once at a stop and sometimes a couple of times. After having collected all waste in one collection area, it might continue to another one, located some distance away, such as another city district. When the waste container of the vehicle is full, it is taken to the incineration plant, where it is emptied. Then it might go back to the garage or to another waste collection area to continue collecting waste.'' NB: Figure 8 in the text above is figure 8 at page 22 in the report. This process is included in the system described in ''Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries	
Nature Boundary	Not applicable.
Time Boundary	The measurements were made in the year 2004.
Geographical Boundary	The data are results from on board measurements made on a typicla waste collection route on a Volvo diesel waste collection vehicle and a Volvo hybrid waste collection vehicle in Gothenburg, Sweden.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data	
General Activity QMetaData	
Date Conceived	2004
Data Type	Monitored data, discrete
Represents	See 'Function'.

Method	Excerpt from the report (for report see link in 'LitteratureRef'): ''Emissions and fuel consumption from simulated waste collection have been measured by the consultant firm Ecotraffic ERD3 AB together with Renova (Eriksson et al., 2004). On board measurements on a Volvo diesel vehicle and a Volvo hybrid (both of model FL6E) were used in this study.'' Time measurements, emission calculations and aother considerations when dealing with the fuel consumption simulation can be found in chapter 3.3 in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Average speed is 50 km/h and typical transportation distance is 4.67 km/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Diesel	368			g	Technosphere	
	Output	Emission	CH4	1.9			g	Air	Sweden
	Output	Emission	CO	1.5			g	Air	Sweden
	Output	Emission	CO2	1003			g	Air	Sweden
	Output	Emission	Hydrocarbons	0.6			g	Air	
	Output	Emission	NOx	2.0			g	Air	Sweden
	Output	Emission	Particles	0.0300			g	Air	Sweden

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Process data in a Master Thesis Report.
Detailed Purpose	This process data set is a part of the comparative LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Renova AB - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpts from the report (for report see link in 'Publication'): ''For evaluation of a gas vehicle, measurements from the hybrid vehicle with the engine kept running at the stops were used. The values were also adjusted according to weight differences due to the extra hybrid electric equipment. The reason for not using data directly from a gas vehicle is because the gas vehicles Renova has is of an older model and have another engine type.'' ''Another important note is that the hybrid vehicle uses a catalytic converter that reduces methane emissions by 80 percent and the diesel vehicle uses a ''CRT particle filter'', which reduces emissions of particles, NOx and CO (Jensen, personal communication). The diesel vehicle fulfils the Euro 3 emission standards.'' ''Measurements were carried out during the different phases related to waste collection. While driving the vehicle at approximately constant speed, 50 km/h, transportation to and from a waste collection area was simulated. Waste collection within a collection area was simulated in a track where driving for 30 seconds followed by a 2 minutes 30 seconds stop for collection, loading and compacting. There are also measurements for idling and loading/compacting separated from the collection track. The measurements for transportation (to and from a collection area) are related to distance and the measurements for collection area driving and collection stop are related to time.'' ''To sum up, the times and distances are: Collection stop time: 1573 seconds/ton Collection area driving time: 503 seconds/ton Transportation distance, conventional vehicle: 4.67 km/ton Transportation distance, hybrid vehicle: 4.77 km/ton'' ''Emissions and resource use during electricity production were calculated using data for average Swedish electricity production (see section 3.1.2).'' NB: Section 3.1.2 is a section in the report. ''Other energy carriers used include diesel, natural gas and fuel oil. Data about production of these were found in a study of production and use of several fuels (Uppenberg et al., 1999). Use of crude oil/natural gas as resource was not included in Uppenberg et al. Instead these resources used were assumed to be of the same amount as the fuel used (1 kg of crude oil for the use of 1 kg of fuel oil or diesel and 1 kg of natural gas for the use of 1 kg of natural gas as fuel). For a few processes, combustion of fuels (fuel oil, diesel and liquefied petroleum gas - LPG) was added using data from the energy and transport database included in LCAiT (CIT Ekologik, 2003). Also data for the production of LPG was taken from this database. Facts from Uppenberg et al.

	were also used to recalculate fuel amount between units of mass, volume and energy content.'' NB: Complete references to Uppenberg et al. (1999) and CIT Ekologik (2003) can be found in the report. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP
Functional Unit	1 km of transportation
Functional Unit Explanation	1 kilometer of transportation on a typical waste collection route.
Process Type	Unit operation
Site	Gothenburg, Sweden
Sector	Land transport
Owner	Gothenburg, Sweden
Technical system description	Fuel demand and emissions during transportation with a hybrid (gas-electric driven) waste collection vehicle. Excerpt from the report (for report see link below): ''3.3 Use of the vehicle 3.3.1 Description of a typical waste collection route In the inventory description of the use phase the waste collection route is divided into three ''sub phases'', illustrated in Figure 8. Driving the vehicle from the garage to a waste collection area, between waste collection areas, to the incineration plant and back to the garage is in this report labelled transportation. Within a waste collection area the vehicle drives short distances between sites where waste is collected. This collection area driving is separated from the transportation to and from collection areas because it is another type of driving, generally much slower and with more acceleration and braking, which leads to other exhaust emissions. At the collection stops, waste bins are collected, the waste is loaded into the vehicle and it is then compacted. A conventional vehicle keeps the engine running at the stops, idling when the workers collect waste bins and working when loading and compacting waste. In a hybrid vehicle the engine is turned off 30 seconds after it has stopped, and the electric motor is then used for loading and compacting. Sometimes the loading and compacting procedure is carried through only once at a stop and sometimes a couple of times. After having collected all waste in one collection area, it might continue to another one, located some distance away, such as another city district. When the waste container of the vehicle is full, it is taken to the incineration plant, where it is emptied. Then it might go back to the garage or to another waste collection area to continue collecting waste.'' NB: Figure 8 in the text above is figure 8 at page 22 in the report. This process is included in the system described in ''Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication:

	Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	The measurements were made in the year 2004.
Geographical Boundary	The data are results from on board measurements made on a typicla waste collection route on a Volvo diesel waste collection vehicle and a Volvo hybrid waste collection vehicle in Gothenburg, Sweden.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	Excerpt from the report (for report see link in 'LitteratureRef'): ''Emissions and fuel consumption from simulated waste collection have been measured by the consultant firm Ecotraffic ERD3 AB together with Renova (Eriksson et al., 2004). On board measurements on a Volvo diesel vehicle and a Volvo hybrid (both of model FL6E) were used in this study.'' Time measurements, emission calculations and aother considerations when dealing with the fuel consumption simulation can be found in chapter 3.3 in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Average speed is 50 km/h and typical transportation distance is 4.77 km/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Diesel	383			g	Technosphere	
	Output	Emission	CH4	2.0			g	Air	Sweden
	Output	Emission	CO	1.6			g	Air	Sweden
	Output	Emission	CO2	1044			g	Air	Sweden
	Output	Emission	Hydrocarbons	0.6			g	Air	Sweden
	Output	Emission	NOx	2.1			g	Air	Sweden
	Output	Emission	Particles	0.0312			g	Air	Sweden

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Process data in a Master Thesis Report.
Detailed Purpose	This process data set is a part of the comparative LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Renova AB - .
Practitioner	Anna Boss - .
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.

About Data	Excerpts from the report (for report see link in 'Publication'): ''For evaluation of a gas vehicle, measurements from the hybrid vehicle with the engine kept running at the stops were used. The values were also adjusted according to weight differences due to the extra hybrid electric equipment. The reason for not using data directly from a gas vehicle is because the gas vehicles Renova has is of an older model and have another engine type.'' ''Another important note is that the hybrid vehicle uses a catalytic converter that reduces methane emissions by 80 percent and the diesel vehicle uses a ''CRT particle filter'', which reduces emissions of particles, NOx and CO (Jensen, personal communication). The diesel vehicle fulfils the Euro 3 emission standards.'' ''Measurements were carried out during the different phases related to waste collection. While driving the vehicle at approximately constant speed, 50 km/h, transportation to and from a waste collection area was simulated. Waste collection within a collection area was simulated in a track where driving for 30 seconds followed by a 2 minutes 30 seconds stop for collection, loading and compacting. There are also measurements for idling and loading/compacting separated from the collection track. The measurements for transportation (to and from a collection area) are related to distance and the measurements for collection area driving and collection stop are related to time.'' ''To sum up, the times and distances are: Collection stop time: 1573 seconds/ton Collection area driving time: 503 seconds/ton Transportation distance, conventional vehicle: 4.67 km/ton Transportation distance, hybrid vehicle: 4.77 km/ton'' ''Emissions and resource use during electricity production were calculated using data for average Swedish electricity production (see section 3.1.2).'' NB: Section 3.1.2 is a section in the report. ''Other energy carriers used include diesel, natural gas and fuel oil. Data about production of these were found in a study of production and use of several fuels (Uppenberg et al., 1999). Use of crude oil/natural gas as resource was not included in Uppenberg et al. Instead these resources used were assumed to be of the same amount as the fuel used (1 kg of crude oil for the use of 1 kg of fuel oil or diesel and 1 kg of natural gas for the use of 1 kg of natural gas as fuel). For a few processes, combustion of fuels (fuel oil, diesel and liquefied petroleum gas - LPG) was added using data from the energy and transport database included in LCAiT (CIT Ekologik, 2003). Also data for the production of LPG was taken from this database. Facts from Uppenberg et al. were also used to recalculate fuel amount between units of mass, volume and energy content.'' NB: Complete references to Uppenberg et al. (1999) and CIT Ekologik (2003) can be found in the report. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Treatment of waste oil from industries and municipalities

Administrative	
Finished	Y
Date Completed	1999-04-15
Copyright	
Availability	Public

Technical System	
Name	Treatment of waste oil from industries and municipalities
Functional Unit	1 m3 of treated oil

Functional Unit Explanation	The choice of functional unit is based on that the oil treatment at Reci Göteborg is seen as a part of the system converting waste oil into fuel oil.
Process Type	Gate to gate
Site	Reci Industri AB Box 48047 418 21 Göteborg
Sector	Waste treatment
Owner	Reci Industri AB Box 48047 418 21 Göteborg
Technical system description	Waste-oil treatment The facility treats both waste-oil, lubricating oil and fat. Lubrication oil and fat undergoes the same treatment as waste-oil. The oil is delivered by sludge-suction-truck to special receiving tanks, where it is analysed and controlled on among other things the PCB-contents. Waste-oil delivered in oil drums are emptied by sludge-suction-truck to the reception tanks and are controlled in the same way. After approved analysis the waste-oil is pumped via a rotating strainer where oil, water and particles are separated. The oil-contaminated water is pumped to the water treatment facility and the solid particles are transported to Sävenäs, a waste fuelled power plant. The oil is, after the filtering, sent to a number of processing tanks, i.e. settling tanks. The process of separation into oil and water is speeded by heating the oil waste to 60ºC. The oil phase is derived from the top through swivel arrangement and is, after further filtering, stored in storing tanks. Oil-sludge, caused by sedimentation in the oil tanks, is derived when the tanks are cleansed with Autosafe 3000 and transported to SAKAB. The treated oil leaves the plant by boat for further processing at Reci's facility in Halmstad. The transportations are not considered in this system.

System Boundaries

Nature Boundary	Resources that are not seen as limited in Sweden are neglected e.g. land usage and fresh water. The electricity utilised by the system is only seen as a resource and the origin is not interpreted.
Time Boundary	The study only deals with retrospective data from and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary for the tretment of waste-oil is set to Sweden.
Other Boundaries	The input resource, Autosafe 3000, is emitted through the oil-sludge. As the oil-sludge leaves the facility for combustion at SAKAB its impact on the environment can't be calculated at Reci Göteborg. The emission caused by Autosafe must though be taken under consideration when the sludge is combusted at SAKAB, and depends on the process at this facility. The pollutants in the wastewater are not represented here. The wastewater is sent to the water treatment facility. As the facility is seen as a subsystem to the oil treatment, emissions caused by the wastewater are included there. No spill occurs in the plants. The loading and unloading step is neglected in terms of consuming resources or emitting outputs. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected.
Allocations	According to the functional unit only the resource use and emissions from treatment of the waste-oil are of interest, therefore are only those impacts accounted for. The waste-oil is supposed to contain 30 % water. Fat and lubricating oil are supposed to demand the same resource use per m3 as waste-oil. The electricity demand for oil treatment is estimated to 85 % of the total use for the facility (Lars Schaff, environmental manager Reci Industri Göteborg). The oil contamination of the water in the surface water system is supposed to be caused exclusively by the oil treatment process. Measurements on the amount of water in the system was performed during the period January-September. Since this is the only available data it is assumed to represent the total amount of water generated in the system.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Unspecified
Represents	See 'Function'.

Method	Data are acquired from a study of the environmental report for Skarvik of 1997 and inquires to the employees at Reci Industri AB. The subtances are divided with the total amount of treated oil to represent the amount per functional unit.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Average speed is 50 km/h and typical transportation distance is 4.77 km/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1997 Data type: Economical information Method: Total amount used 1,75 m3. Literature: Environmental report Skarvik 1997 Notes: The degreasing agent, Autosafe 3000, is emitted through the oil sludge. Product information Autosafe 3000 Company of distribution: Lahega Kemi AB Box 10073 25013 Helsingborg phone: +46 -42 201700 Product composition: Natriummetasilikat 1-5% 2-Aminoctanol 5-15% Noniontensider <5% Dipropionat <5% Water	Input	Refined resource	Degreasing agents	0.0002			m3	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: The total use of electricity for Skarvik was 2.2 GWh. The waste oil treatment is considered to demand 85% of the total use. Literature: Environmental report for Skarvik of 1997 Notes: The electricity is delivered by Göteborgs Energi.	Input	Refined resource	Electricity	197.88			kWh	Technosphere	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: Delivering sludge-suction-trucks are weighted to determin the amount of recieved waste-oil. Literature: Environmental report for Skarvik of 1997. Dennis Göthe, process engineer at the water treatment facility (Ciclean). Christian Arte´n, process engineer at Skarvik Notes: The inflow of waste oil was totally 22 436 tonnes during 1997. The composition was as follows: Waste oil 19 326 tonnes Lubrication oil 3 017 tonnes Lubrication fat 93 tonnes Lubrication- oil and fat are considered to have the same resource use and emissions per ton as waste-oil.	Input	Refined resource	Waste oil	2.374			tonne	Technosphere	Sweden
Date concieved: 1997 Data type: Unspecified, expert outspoke Method: The emission is estimated to about 5 ton/year based on the pressure in the oil cisterns. Literature: Mati Hell, innovation engineer at Reci Göteborg. Notes: Emission to the air from the oil tanks. When light fraction products are delivered they are gathered in a special tank that is not ventilated to the air. 5 tonnes of hydrocarbons are emitted to the air by tank breathing.	Output	Emission	HC	529.1			g	Air	Sweden
Date concieved: 1997 Data type: Economical information Method: The amount of treated oil is measured when loaded to vessel for transportation to Reci Halmstad. Total amount of treated oil produced during 1997 was 9450 m3. Literature: Environmental report Skarvik 1997. Christian Artén process engineer Skarvik, Reci Göteborg. Notes: Functional unit. The oil is transported to Reci Halmstad for further treatment.	Output	Product	Treated oil	1			m3	Technosphere	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: Based on an arithmetically average the outflow of water was approximately 942 m3/month. The minimum value was 555 m3/month and the maximum value 1363 m3/month. The total outflow during 1997 was 13 752 m3. (Environmental	Output	Residue	Oil-contaminated waste water	1.455			m3	Technosphere	Sweden

report). The outflow is measured as the water is pumped to Ciclean, the water treatment facility.(Lars Schaff) Literature: The environmental report for Skarvik, Reci Göteborg of 1997. Christian Artén process engineer, Skarvik Reci Göteborg. Lars Schaff environmental manager Reci Göteborg. Notes: The water phase from the settling tanks is gathered in a special tank (Christian Artén) where it is controlled with respect to the amounts of COD, mineral oil and TEX. The specimens are gathered monthly and every day one specimen is added and mixed with the previously taken specimens that month. Controlled water is pumped to Ciclean to be treated. (Environmental report)									
Date concieved: 1997 Data type: Calculated Represents: Reci Industri AB Halmstad. Method: Inquiry with the manager at Reci Halmstad, Bengt Borg. The treated waste oil is supposed to cause a sedimentation of 0,25%/m3 at Reci´s facility in Halmstad. The data is supposed to be representative for the sedimentation in Skarvik as well, calculated on the amount of treated oil. Literature: Bengt Borg production manager at Reci Industri Halmstad Notes: The oil sludge, caused by sedimentation in the tanks, is derived when the tanks are cleansed. As this is not an every-year-procedure the amount sedimentated per cubic metre is estimated as above. The oil sludge is transported to SAKAB for destruction.	Output	Residue	Oil-sludge	0.0025			m3	Technosphere	Sweden
Date concieved: 1997 Data type: Unspecified, expert outspoke Method: Inquiry to Christian Artén process engineer, Skarvik Reci Göteborg. Literature: Christian Artén process engineer Skarvik Notes: Derived scrap from filtering. The scrap is transported to Sävenäs, a waste fuelled power plant.	Output	Residue	Scrap	0.0159			tonne	Technosphere	Sweden
Date concieved: 1997 Data type: Monitored data, discrete Method: Based on an arithmetically average from 6 measurements the outflow of water was approximately 122 m3/month. The minimum value was 0 m3/month and the maximum value 282 m3/month. The total outflow during 1997 was 1101 m3 (refers to the total outflow during january-september). (Environmental report) Literature: Environmental report Skarvik of 1997 Notes: The water phase from the surface water system is gathered in a special tank where it is controlled with respect to the amounts of COD, mineral oil and TEX. Controlled water is, among with other oil-contaminated water, pumped to Ciclean to be treated. The pollution of the surface water is supposed to be caused exclusively by the treating of waste oil.	Output	Residue	Surface water	0.116			m3	Technosphere	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology -- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Internal use at Reci Industri

General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally the result is a part of Reci's ISO 14000 certification, which acts as a guarantee to the customers. The quality of the inquiry is set due to the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emissions released from treatment of waste-oil.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are site-specific for treatment of waste-oil. As some of the data is allocated and some are achieved through estimations and coarse measurements the result should be seen as an estimation of the emissions.
About Data	Mass balance Total in about 22436 m3 Total output about 19994 m3 Difference: 2442 m3 When calculating the mass balance 1 ton was supposed to be equivalent with 1 m3, which can explain some of the difference. When put into perspective of the total inflow the difference can be assumed to be a measurement error. As the treatment of waste-oil is a continual process and flows are only measured when entering or leaving the system it is also plausible that a significant volume was still in the system when inflows and outflows where reported. The most likely explanation is a measurement error on the outflow of water or that accumulated water where not pumped to Ciclean when finishing the report. The total outflow of water was 11 310 m3. To achieve mass balance the outflow is supposed to be 2442 m3 higher.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil'' Reci's plant at the harbour of Skarvik receives and treats hazardous waste from industries and municipalities in the western parts of Sweden. The company is part of Scancem Energy and Recovery Ltd (former Cementa Miljöteknik AB). The plant also works as a bussing station for the resource- and contribution emergency-service concerning clearing at oil- and chemical-accidents in the region. The main activity at the plant concerns pre-treatment of waste oil, emulsions and cutting fluids before sending the derived oil to Reci Halmstad for final treatment.

SPINE LCI dataset: Treatment of hazardous waste

Administrative	
Finished	Y
Date Completed	1999-04-18
Copyright	
Availability	public

Technical System	
Name	Treatment of hazardous waste
Functional Unit	1 m3 of oil-sludge
Functional Unit Explanation	Oil-sludge delivered from Reci Industri AB. Waste product, origins when the oil cisterns are cleansed. Oil-sludge is delivered to SAKAB by truck from: Reci Halmstad about 237 m3 Reci Göteborg oil treatment 24 m3 Reci Göteborg water treatment facility 12 m3 The oil-sludge mainly consists of water, sediment and a smaller amount of oil. The oil-sludge also contains de-greasing agents used when the tanks are cleansed from oil-sludge. The total amount used is not known. With the assumption that the agent is petroleum based it contains to 97 per cent of hydrocarbons and 3 per cent surfactants.
Process Type	Gate to grave
Site	SAKAB Box 904 69229 Kumla Sweden
Sector	Waste treatment

Owner	SAKAB Box 904 69229 Kumla Sweden
Technical system description	SAKAB is located in Norrtorp near Kumla. The company is assigned by the Swedish government to treat environmental hazardous wastes from industries and municipalities. The treatment procedure is to burn the hazardous substances. Waste arrives by sludge-suction-truck, in barrels and a smaller part by train. The substances are stored and later mixed with other substances for supplying the kiln with an evenly mixed fuel. Heat and electrical energy is extracted from the waste when burned. The combustion process The facility is dimensioned for combustion of about 33.000 tonnes per year. Feeding of waste into the kiln is done via the front wall. In the front wall there is also an intake for primary air. The temperature in the kiln is at least 1200°. The heat in the kiln causes the slag that is formed to melt. Most of the heavy metals are made insoluble in the slag by adding of quartz. The slag-melt is derived from the bottom of the afterburner to a slag-distinguish-basin. The slag is then transported in containers to the deposit-site. From the kiln the vapour is lead to the afterburner where secondary and tertiary air is added for complete combustion. The temperature in the afterburner is regulated by fuel oil. The vapour then passes the emission steam furnace where a part of the vapour heat is used for steam production. The generated steam is used for production of electricity and for heating by Kumlas district heating. From the furnace, with a capacity of 20 MW, it is possible to derive 15 MW in heat and electricity. The fumes are then send through a smoke purifier. The process involves mixing the fumes with lime. HCl, HF and SOx react with the lime and the water evaporates. The dry product from the reaction is derived at the bottom and by a following filter. The filter has a layer of lime and active coal that contributes to further deriving of pollution. The purified fumes are led to the chimney. The emissions are difficult to estimate, as the combustion is inhomogeneous. Moreover is the fuel of various compositions. Though a calculation of the sulphur reduction has been made. The sulphur is reduced by 80 per cent, calculated generally for all wastes. Heavy metals are supposed to end up in the slag. Metals with a lower vapour point 1000°C will leave with the fumes, the major part of these metals is supposed to end up in the ashes derived from the kiln and the smoke purifier. A smaller amount of pollutant can be emitted trough the chimney suspended in water particles. The ash and slag are deposited locally at SAKAB.

System Boundaries	
Nature Boundary	Resources that are not seen as limited in Sweden are neglected e.g. land usage and fresh water. The electricity utilised by the system is only seen as a resource and the origin is not interpreted.
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary is set to Sweden.
Other Boundaries	The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. All chlorine and metals are supposed to end up in either the slag or the ashes. The sediment in the oil-sludge is not considered since the amount is unknown.
Allocations	Only the impact made by the combustion of oil-sludge is of interest. It is today impossible to say what emission origin from what specific waste. As oil-sludge mainly consists of sediment and water it is supposed to contribute very little to the emissions from SAKAB. Its contribution will be calculated from the data presented by Reci for the contents of oil-sludge. Due to uncertainty about the process, the use of quartz is not loaded upon the oil-sludge. A smaller amount of quartz is though supposed to be used by the oil-sludge.
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1997
Data Type	Unspecified
Represents	See 'Function'.
Method	The data collected are secondary. The general decription of the plant is taken from the environmental report of 1997 for SAKAB. The information about reduction of emissions and energy calculations are achieved through interviews with Karl-Johan lötgren, process engineer and nils lovang, information manager at SAKAB. Emission data are taken from the SPINE report ''Combustion of oil'' The calculations are based on data about the oil-sludge from an analyse in 1991 achieved at Reci Industri Halmstad. The subtances are divided with the amount of treated waste to represent the amount per functional unit.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf

Notes	Average speed is 50 km/h and typical transportation distance is 4.77 km/ton collected waste.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Data type: Calculated Method: Lime Supposed to consist exclusively of CaCO3, reduces the sulphur by 80 per cent and the chlorine by 100 per cent. The reduced substance end up in either the slag or the ashes derived when filtering. (Nils Lovang) Sulphur reduction Oil-sludge has a sulphur content of 2-weight per cent. Density = 1000 kg/m3. With a reduction of 80 per cent, the sulphur ending up in the slag and ashes is 16 kg / m3. CaCO3 --> CaO + CO2 2 CaO + 2 S + 3 O2 --> 2 CaSO4 For reduction of two parts of sulphurs the process: demands 2 parts of CaCO3 produces 2 parts of CO2 2 parts of CaSO4 Based on the molar weight 1 kg S demands 100/(2*32) = 1,56 kg CaCO3 produces 44/(2*32) = 0,6875 kg CO2 136/(2*32) = 2,125 kg CaSO4 Chlorine reduction The amount of chlorine in the oil-sludge is based on an average from three analysis: (0.13*0,51+0,6)/3 = 0,41 weight% With a density on the oil-sludge of 1000 kg/m3 the amount of chlorine will be 4.1 kg/m3. CaCO3 --> CaO + CO2 2 CaO + 4 Cl --> 2 CaCl2 + O2 For reduction of four parts of chlorine the process: demands 2 parts of CaCO3 produces 2 parts of CO2 2 parts of CaCl2 Based on the molar weight 1 kg Cl demands 2*100/(4*35,5) = 1,408 kg CaCO3 produces 2*44/(4*35,5) = 0,6197 kg CO2 2*111/(4*35,5) = 1,5633 kg CaCl2 Total amount of lime demanded: (16*1.56+4.1*1.408)*277= 8513 kg Literature: Nils Lovang information manager SAKAB.	Input	Refined resource	Lime	30.73			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Calculated Method: The amount of oil-sludge is calculated based on the amount of waste-oil treated at Reci Industri's facilities. Literature: Spine report: Processing of waste-oil into fuel oil. Treatment of waste-oil from industries and municipalities Treatment of oil-contaminated waste water Processing of waste-oil into fuel oil Notes: The oil-sludge mainly consists of sediment, water and a smaller part of oil. Density 1000 kg/m3 Energy content 15,6 MJ/m3 Oil content 18 MJ/m3 Oil-sludge delivered to SAKAB by truck from: Reci Industri Halmstad about 241 m3. Reci Industri Göteborg oil treatment 24 m3. Reci Industri Göteborg water treatment facility 12 m3. The oil-sludge contains degreasing agents used when the tanks are cleansed from oil-sludge. The total amount used is not known. With the assumption that the agent is petroleum based it contains to 97% of hydrocarbons and 3% surfactants according to ''Bilvårdsprodukter: möjligheter till förändring.'' Jan Nilsson-Ahlbom and Ulf Duus, Kemikalieinspektionen 1990	Input	Refined resource	Oil-sludge	1			m3	Technosphere	Sweden
Date concieved: 1997 Data type: Calculated Method: According to the SPINE report ''Combustion of oil'' 0,007 g / MJ Ashes is emitted. Oil-sludge: Amount 277 m3 Oil content 18 MJ / m3 Amount emitted ashes: 0,007*277*18 = 34,9 g Literature: Analyse information from 1991 on oil-sludge achieved from Reci Industri Halmstad. SPINE report ''Combustion of oil''	Output	Emission	Ashes	0.126			g	Air	Sweden

Date concieved: 1997 Data type: Calculated Method: According to the SPINE report ''Combustion of oil'' 0,013 g / MJ CO are emitted. Oil-sludge: Amount 277 m3 Oil content 18 MJ / m3 CO emission: 0,013*277*18 = 64,18 g Literature: Analyse information from 1991 on oil-sludge achieved from Reci Industri Halmstad. SPINE report ''Combustion of oil''	Output	Emission	CO	0.234			g	Air	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on calculation performed for the substance Lime, see above. CO2 emission from sulphur reduction: 0,6875 kg / kg S S reduced 16 kg / m3. Amount oil-sludge 277 m3 0,6875*16*277 = 3047 kg. CO2 emission from chlorine reduction: 0,6197 kg / kg Cl Cl reduced 4,1 kg / m3 0,6197*4,1*277 = 703,8 kg CO2 emission from combustion of oil according to the SPINE report ''Combustion of oil'' 75,8 g/MJ Oil content 18 MJ / m3 0,0758*18*277 = 377,94 kg Total amount of emitted CO2 = 4128,74 kg. Literature: Analyse information from 1991 on oil-sludge achieved from Reci Industri Halmstad. SPINE report ''Combustion of oil''	Output	Emission	CO2	14905			g	Air	Sweden
Date concieved: 1997 Data type: Calculated Method: According to the SPINE report ''Combustion of oil'' 0,010 g / MJ HC are emitted. Oil-sludge: Amount 277 m3 Energy content 15 MJ / m3 Amount emitted HC: 0,010*277*18 = 49,86 g Literature: Analyse information from 1991 on oil-sludge achieved from Reci Industri Halmstad. SPINE report ''Combustion of oil''	Output	Emission	HC	0.18			g	Air	Sweden
Date concieved: 1997 Data type: Calculated Method: According to the SPINE report ''Combustion of oil'' 0,15 g/MJ NOx is emitted. Amount Oil-sludge 277 m3 Oil content 18 MJ/ m3 Amount of NOx: 0.15*18*277 = 747,9 g Literature: SPINE report ''Combustion of oil''	Output	Emission	NOx	2.7			g	Air	Sweden
Date concieved: 1997 Data type: Calculated Method: According to the SPINE report ''Combustion of oil'' 0,030 g / MJ particles are emitted. Oil-sludge: Amount 277 m3 Energy content 18 MJ / m3 Amount emitted ashes: 0,030*277*18 = 149,58 g Literature: Analyse information from 1991 on oil-sludge achieved from Reci Industri Halmstad. SPINE report ''Combustion of oil''	Output	Emission	Particles	0.54			g	Air	Sweden
Date concieved: 1997 Data type: Calculated Method: The sulphur content is 2-weight per cent in the oil-sludge. The density is approximated to 1000 kg / m3 because of the high water contents. (Reci) The emission is calculated to be reduced by 80 per cent and the emitted sulphur (20%) leaves as SO2. This gives an emission of SO2 by 8 kg/m3. (Lovang) 2%*1000*20%*(32+2*16)/32 = 8 kg/m3 Total amount SO2 emitted: 8*277 = 2216 kg. Literature: Analyse information from 1991 on oil-sludge achieved from Reci Industri Halmstad. Nils Lovang information manager SAKAB.	Output	Emission	SO2	8000			g	Air	Sweden
Date concieved: 1997 Data type: Calculated Method: The oil-sludge is supposed to generate 15,6 MJ/m3 during combustion. (Reci) 1 MJ = 1000/3600 kWh. The furnace has a capacity of 20 MJ and its possible to derive 15 MJ energy from the process. (Lötgren) This gives an energy production of 3,25 kWh/m3. Literature: Karl-Johan Lötgren process engineer SAKAB. Analyse information	Output	Product	Electricity/Heat	3.25			kWh	Technosphere	Sweden

from 1991 on oil-sludge achieved from Reci Industri Halmstad.									
Date concieved: 1997 Data type: Calculated Method: Calculated based on the sulphur and chlorine reduction. Amount of CaCl2 per kg reduced Cl = 1,5633 kg Amount of CaSO4 per kg reduced S = 2,125 kg Amount of slag: 277*4,1*1,5633+277*16*2,125 = 11 193,44 kg.	Output	Residue	Slag/Ashes	40.41			kg	Technosphere	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology -- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally the result is a part of Reci's ISO 14000 certification, which acts as a guarantee to the customers. The quality of the inquiry is set due to the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emissions from combustion of oil-sludge at SAKAB.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are specific for treatment of oil-sludge from Reci Industri at SAKAB.
About Data	Emissions are calculated based on data about the oil-sludge's contents. The data is received from analysing the oil-sludge at Reci Halmstad AB. The emissions represented in the environmental report is allocated to the other wastes. · The oil-sludge also contains de-greasing agent, which is used when deriving the sludge from the cisterns. The hydrocarbons in the agent are supposed to be comparable with the oil in the oil-sludge, surfactants and other eventual contents are supposed to end up in the slag or ashes and are not taken under consideration. As the amount slag and ashes formed by the oil-sludge is unknown it is calculated based on the sulphur and chlorine reduction. In reality the oil-sludge uses some active coal, quartz and surely reacts with elements in the other wastes but this is not taken under consideration. No massbalance has been calculated since the exact resource use and emissions are not known. the result is based on the calculation approaches stated above and are believed to accomplish a good estimation of the process.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Treatment of hazardous waste from industries and municipalities

Administrative

Finished	Y
Date Completed	1994-03-01
Copyright	
Availability	Public

Technical System

Name	Treatment of hazardous waste from industries and municipalities
Functional Unit	ton

Functional Unit Explanation	1 ton by AB GRAAB-KEMI received waste 1,0 ton waste consist of: Waste oil 0,6248 m3 Waste lubricating oil 0,1709 m3 Waste lubricating fat 0,02239 ton Waste emulsions 0,04290 m3 Acid/Alkaline/Heavy metal containing waste 0,01833 ton Waste chemicals 0,1207 ton ____ Tot 1,0 ton
Process Type	Gate to gate
Site	AB GRAAB KEMI Box 4047 4121 Göteborg Sweden
Sector	Waste treatment
Owner	AB GRAAB KEMI Box 4047 4121 Göteborg Sweden
Technical system description	The GRAAB-KEMI plant at the harbour of Skarvik receives and treats hazardous waste from industries and municipalities from the western parts of Sweden. The company is part of the Euroc Recycling AB (former Cementa Miljöteknik AB). The plant also works as a bussing station for the resource- and contribution emergency service concerning clearing at oil and chemicals accidents in the region. The main treatment at the plant conserns reprocessing of waste oil, treatment of emulsions and cutting fluids and liquid chemical treatment of acid, alkaline and heavy metal containing waste fluids. The cleaning plants Oil containing water from the oil reception plant is pre-treated in a separator (type centrifuge) and is gathered together with other oil containing surface water from oil-contaminated surfaces in a separate tank, before it is pumped to Ciclean for final cleaning. Used cutting fluids and emulsions are treated in a experimental plant by means of evaporation. The thickened oil phase (the concentrate) is destroyed at SAKAB. The water phase (the condense) is cleaned through two polymere filters connected in series and finaly through a charcoal filter. After this the water is led to Ciclean together with all the oil-contaminated water. At liquid chemical treatment the heavy metals are seperated as hydroxide sludge. After chamber filter pressing the rejected water is stored in tanks for analysis, before it is let out into the surface water net of Göteborgs Hamn. A more detailed description of the treatment of the waste folows below: Waste oil The oil is delivered by sludge-suction-car in special delivery tanks to be analysed and controlled on among other things the PCB-contents. After approved analysis the waste oil can via a rotating strainer be pumped to a number of processing tanks. The process of separation into oil and water is speeded by heating the oil waste to 60 deg C. The oil phase is taken out from the top through swivel arrangement and is stored in storing tanks to be transported by boat or car to an approved external combustion or treatment plant. If the oil is delivered in barrels it is emptied by sludge-suction-car to a delivery tank like above and is controlled in the same way. Lubricating oil Lubricating oil with low water content is edmitted and stored after PCB-control and mechanical straining in separate tanks. The oil is transported to external permitted plants as above. Oil-contaminated water Oil-contaminated water from the plant, flushing areas included, is gathered via pumping pit into a scrap-tank, from where it is pumped to Ciclean to be treated. Separation of oil-contaminated water from processing tanks and flushing areas has started. Used cutting fluids and emulsions Used cutting fluids and emulsions are treated in an experimental plant by means of evaporation. From this process you get one thicker oil phase, which is transported to SAKAB for destruction, and one water phase, which after among others cleaning by charcoal filter is taken to Ciclean for final treatment. Liquid chemical treatment Acid, Alkaline and heavy metal containing waste The waste arrives to the plant in bulks, by sludge-suction-cars as well as in barrels and smaller packings and is transferred to special storage tanks. The treatment is done batch by batch in a reactor, where different processing chemicals are added. When the process is done and the substance cooled it is pumped to a tank for temporary storage. From this tank the liquid is led into a chamber-filter-press, where the water is removed and a solid filter-cake is made. The water from the press is gathered in a tank and is let out into the surface water net, after it has been controlled. The solid, dry filter-cake is transported to Torsviken to be dumped. Mercury containing waste Mercury containing COD-waste from laboratories is treated in the chemical liquid plant. Dewatered mercury containing filter sludge is sent to SAKAB to be dumped. Other mercury containing waste is temporary stored, at a special place, to later on be transported to external certified recycling or dumping companies.

	The handling of chemicals Waste oil Waste oil, contaminated by paint, solvents, poison, solid contaminations and other chemicals is delivered to the plant mainly in barrels. Waste in smaller packings are tapped manually to larger barrels. The barrels are stored at a special place, to later on be transported to SAKAB. Waste solvents The waste arrives to the plant mainly in barrels. The barrels with solvents are stored at a special place, sectioned for chlorated and non chlorated solvents. Smaller packages is handeled in a special solvents-room, where they are emptied by pumps into barrels.The barrels are cleaned through suction by sludge-suction-car and is transported to be temporary stored in hired tanks at Paktank AB, from where the waste is transported to external waste recycling or destruction companies. Routine controls are done before departure. Waste paint The waste arrives to the plant in barrels or smaller packings and is stored. After possible retapping the waste is transported to SAKAB for destruction. Waste glue Is treated in the same way as waste paint. Acid or alkaline waste This waste consists mainly of organic and inorganic acids and lyes and such alkaline waste, that is not processable in the chemical liquid plant. The waste arrives to the plant mainly in barrels. The waste is stored temporary before it is transported to external destruction or dumping companies. Cadmium containing waste The waste arrives to the plant mainly in barrels. The waste is stored temporary before it is transported to external destruction or dumping companies. Heavy metal containing waste The waste arrives to the plant mainly in barrels. The waste is stored temporary before it is transported to external destruction or dumping companies. Some dewatered metal hydroxides can be dumped at Torsviken and some metal contaning baths can be processed in the chemical liquid plant. Cyanide containing waste The waste is handled in the same way as cadmium containing waste. PCB-containing waste Small amounts of PCB-containing waste of the type condensers are taken to the plant and is packed in special packages before they are transported to SAKAB for destruction. Handling as emptying of transformers are not done in the plant. Waste biocides The waste arrives to the plant in various kinds of packing. Liquid waste is tapped on barrels and solid waste is put in boxes. The waste is transported to SAKAB for destruction. Waste from laboratories The waste arrives to the plant in various kinds of packing and is stored at a special place at the plant. Waste that will be transported to SAKAB, whithout change of package, is packed according to SRVFS 1989:2. Certain laboratory waste can be processed in the chemical liquid plant. Laboratory waste as solvents is handled as waste solvents as seen above.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1993
Data Type	Unspecified
Represents	See 'Function'.

Method	Study the Environmental report The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1993. The annual proiduction amounted to 10583 ton received waste in the year 1993.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	the companies used for taking of specimens and analysing are Svenska Saybolt AB, AL Control, Kemianalys AB, Chemcontrol AB and AB AnalyCen

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1993 Data type: Unspecified Notes: (Lensitil H23M) Used for degreasing and is let out with the waste water.	Input	Refined resource	Degreasing agents	0.056694699			l	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: The substance is used for settling of oil and parts of the substance is let out with the waste water, the rest ends up as wast oil (see residue, waste oil)	Input	Refined resource	Demulsifier	0.018898233			l	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: 98,1% is used as fuel (0,1% S) 1,87% of the substance is used as a processing chemical. The rest products from the substance is transported to Leto/Värnamo.	Input	Refined resource	Diesel	0.013606728			m3	Technosphere	
	Input	Refined resource	Electricity	0.000226779			GWh	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: (Expander) Used for degreasing. The substance is let out with the waste water.	Input	Refined resource	Emulsifier	0.037796466			l	Technosphere	
	Input	Refined resource	Fuel oil	0.000188982			m3	Technosphere	
	Input	Refined resource	Gasoline	0.001105547			m3	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: 1 ton by AB GRAAB-KEMI received waste consist of: Waste oil 0,6248 m3 Waste lubricating oil 0,1709 m3 Waste lubricating fat 0,02239 ton Waste emulsions 0,04290 m3 Acid/Alkaline/Heavy metal containing waste 0,01833 ton Waste chemicals 0,1207 ton Tot 1,0 ton	Input	Refined resource	Hazardous waste	1			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Used as a processing chemical. Rest products are dumped at Torsviken.	Input	Refined resource	Slaked lime	0.103940282			kg	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: The substance is used for cleaning and is let out with the waste water.	Input	Refined resource	White spirit	0.033071908			l	Technosphere	
Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a geometrical average from 12 specimens. The specimens are gatherd monthly and every day one specimen is added and mixed with the previously taken specimens that month. Notes: Emission in the oil-contaminated waste water.	Output	Emission	Aromatics	0.000661438			kg	Technosphere	
Date concieved: 1993 Data type: Unspecified Method: Based on a geometrical average from 12 specimens. The specimens are gatherd monthly and every day one specimen is added and mixed with the previously taken specimens that month. Notes: Emission in the oil-contaminated waste water.	Output	Emission	COD	0.008787678			tonne	Technosphere	

Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a geometrical average from 32 specimens. Each specimen consist of ceveral specimens. Every day a taking of specimens is done and the specimen is added to the previosly taken specimens. Notes: Emission in the filtered waste water.	Output	Emission	Cr	0.009543608			g	Surface water	
Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a geometrical average from 32 specimens. Each specimen consist of ceveral specimens. Every day a taking of specimens is done and the specimen is added to the previosly taken specimens. Notes: Emission in the filtered waste water.	Output	Emission	Cu	0.010016063			g	Surface water	
Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a geometrical average from 10 specimens. Each specimen consist of ceveral specimens. Every day a taking of specimens is done and the specimen is added to the previosly taken specimens. Notes: Emission in the filtered waste water.	Output	Emission	Hg	0.000236228			g	Surface water	
Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a geometrical average from 12 specimens. The specimens are gatherd monthly and every day one specimen is added and mixed with the previously taken specimens that month. . Notes: Emission in the oil-contaminated waste water.	Output	Emission	Mineral oil	0.000330719			tonne	Technosphere	
Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a geometrical average from 32 specimens. Each specimen consist of ceveral specimens. Every day a taking of specimens is done and the specimen is added to the previosly taken specimens. Notes: Emission in the filtered waste water.	Output	Emission	Ni	0.009260134			g	Surface water	
Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a geometrical average from 32 specimens. Each specimen consist of ceveral specimens. Every day a taking of specimens is done and the specimen is added to the previosly taken specimens. Notes: Emission in the filtered waste water.	Output	Emission	Pb	0.00160635			g	Surface water	
Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a aritmethic average from 5 specimens. The specimens are gatherd monthly and every day one specimen is added and mixed with the previously taken specimens that month. Notes: Emission in the oil-contaminated waste water.	Output	Emission	Phenol	0.000944912			kg	Technosphere	
Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a geometrical average from 18 specimens. Each specimen consist of ceveral specimens. Every day a taking of specimens is done and the specimen is added to the	Output	Emission	Susp solids	0.000576396			kg	Surface water	

previosly taken specimens. Notes: Emission in the filtered waste water.									
Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a geometrical average from 12 specimens. The specimens are gatherd monthly and every day one specimen is added and mixed with the previosly taken specimens that month. Notes: Emission in the oil-contaminated waste water.	Output	Emission	TEX	0.000463007			tonne	Technosphere	
Date concieved: 1993 Data type: Monitored data, discrete Method: Based on a geometrical average from 32 specimens. Each specimen consist of ceveral specimens. Every day a taking of specimens is done and the specimen is added to the previosly taken specimens. Notes: Emission in the filtered waste water.	Output	Emission	Zn	0.00727582			g	Surface water	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB to be dumped.	Output	Residue	Acid or alkaline waste	0.001322876			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and dumped at Torsviken.	Output	Residue	Dewatered hydroxide sludge	0.002645753			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB for combustion.	Output	Residue	Emulsified concentrate	0.001417367			tonne	Technosphere	
Date concieved: 1993 Data type: Monitored data, discrete Method: The amount in the table is based on an geometrical average (The average is 6 m3 / month. Minimum value is 3 m3 / month and maximum value 12 m3 /month.) and devided by the annual production. Notes: The filtered waste water comes from the chemical liquid plant and is led to the surface water system of Göteborgs Hamn. The water contains the amounts of susp solids, Pb, Cu, Cr, Ni, Zn and Hg shovn in the table.	Output	Residue	Filtered waste water	0.01861476			m3	Surface water	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB for combustion.	Output	Residue	Laboratory waste	0.001133894			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and 44,7% is brought to Sävenäs for combustion. the rest is dumped at Tagene.	Output	Residue	Mixed waste	0.004441085			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to Sävenäs for combustion.	Output	Residue	Oil-contaminated scrap	0.013039781			tonne	Technosphere	
Date concieved: 1993 Data type: Monitored data, discrete Method: The amount in the table is based on an geometrical average (The average is 760 m3 / month. Minimum value is 430 m3 / month and maximum value 1040 m3 /month.) and devided by the annual production. Notes: The oil-contaminated waste water is pumped to Ciclean for final treatment. The water contains the amounts of TEX, mineral oil, COD, Phenol and	Output	Residue	Oil-contaminated waste water	0.861192479			m3	Technosphere	

Aromatic substances shovn in the table.									
Date concieved: 1993 Data type: Unspecified Notes: 70,8% is recycled at Bilfragmentering Agnesberg. The waste is transported by AB GRAAB-KEMI. The rest consist of plates, scrap, rubber and plastics. This amount is transported by AB GRAAB-KEMI and is dumped at Tagene.	Output	Residue	Scrap	0.031371067			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is dumped at Torsviken..	Output	Residue	Unwashed package	0.012378343			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB for combustion or long time storage.	Output	Residue	Waste biocide	0.001228385			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB for long time storage.	Output	Residue	Waste containing cadmium	0.000283473			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB for combustion.	Output	Residue	Waste containing cyanide	0.005858452			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB to be dumped.	Output	Residue	Waste containing heavy metals	0.00566947			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB to be dumped.	Output	Residue	Waste containing mercury	0.000566947			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB for combustion.	Output	Residue	Waste containing PCB	0.000944912			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB for combustion.	Output	Residue	Waste glue	0.004346594			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI. 4,86 % is dumped at Torsvikenand the rest is brought to SAKAB for combustion.	Output	Residue	Waste oil	0.0700179533			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by boat and brought to Scanfuel for recycling.	Output	Residue	Waste oil	0.369082491			m3 fub	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to SAKAB for combustion.	Output	Residue	Waste paint	0.012094869			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to Sävenäs for combustion.	Output	Residue	Waste paper and wood	0.002645753			tonne	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: Is transported by AB GRAAB-KEMI and is brought to Leto to be recycled.	Output	Residue	Waste solvents	0.01785883			tonne	Technosphere	

About Inventory

Publication	The environmental report from AB GRAAB-KEMI for 1993, The Board of County in Göteborg and Bohus The Department of Environment -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology

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Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden.
Practitioner	Hell, Mati - AB GRAAB KEMI Box 4047 4121 Göteborg Sweden.
Reviewer	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden
Applicability	The company has its own transportation unit, which collects the waste from there clients, when more resources are necessary more help is hired. All the waste is accompanied by a declaration of contents before it is collected, handled or treated in the company. The tranporting is not part of the system described in the environmental report, so the environmental load from the transporting is not stated in the table. Waste that is not treatable in the plant is sent to SAKAB or other external waste disposal companies to be recycled or stored. The company is part of Göta älvs Vattenförbund and Göteborg och Bohusläns Vattenvårdsförbund.
About Data	The plant was in operation for 252 hours during 1993. The waste received at the plant amounted to 10583 ton during 1993. A more specified list over the received waste follows below: Waste oil 6 612 m3 Waste lubricating oil 1 809 m3 Waste lubricating fat 237 ton Waste emulsions 454 m3 Acid/Alkaline/Heavy metal containing waste 194 ton Waste chemicals 1 277 ton ____ Tot 10 583 ton
Notes	

SPINE LCI dataset: Treatment of oil-contaminated waste water

Administrative	
Finished	Y
Date Completed	1994-03-01
Copyright	
Availability	Public

Technical System	
Name	Treatment of oil-contaminated waste water
Functional Unit	m3
Functional Unit Explanation	1 m3 by Ciclean recieved oil-contaminated waste water The oil-contaminated water that comes to the company consist of: 18,6% Ballas, washing and rejected water from ships and oilcontaminated water which has been taken care of at oil disasters and such. 74,6% Oil-contaminated waste water from surface water systems. 2,23% Oil-contaminated water and sludge from ships. 0,401% Emulsions from industries, petrol stations and municipalities. 0,214% Oil-contaminated water from industries and municipalities. 3,88% Oil-contaminated water from cicterns.
Process Type	Gate to gate
Site	CICLEAN AB Box 48047 41821 Göteborg Sweden

Sector	Waste treatment
Owner	CICLEAN AB Box 48047 41821 Göteborg Sweden
Technical system description	Ciclean AB receives and treats oil-contaminated water from ships and waste oil and emulsions from industries in the western parts of Sweden. The company is an affiliated company of AB GRAAB-KEMI, which is owned by Euroc Recycling AB. Ciclean AB are members of Göta älvens Vattenförbund and Göteborgs och Bohusläns Vattenvårdsförbund. The cleaning processes are based on chemical precipitation with aluminiumsulphate, flotation and sand filtration. The aluminiumsulphate is recycled up to 80% and splited oil is pumped to storage tanks to be transported to certified external receiver. The plant, which has a capacity of 500 m3 / hour devided between two processing lines, can also admit processing water containing gasoline or other petrol products, whith low flash-point. The company are memers in Göta älvs Vattenvårdsförbund and Göteborg och Bohusläns Vattenvårdsförbund. A more detalied description follows below: Whithin the plant there are two tanks, each containing 10 000 m3, used for receiving ballast water and other oil-contaminated, one processing tank (2000 m3), a so called settling tank used for separating oil and water and one storage tank (1500 m3) used for separated oil. The plant alo has six smaller receiving tanks (2 pcs of 230 m3 and 4 pcs of 5m m3) so that the company has flexebility and possibility for separat treatment of extremely contaminated water. Some of the receiving tanks are provided with heating and possibility to draft at the top. Ballas water and redjected water are pumped from ships to Cicleans receiving tanks. Also oil-contaminated water from surface water systems whithin Skarvik's and Rya harbours is pumped to these tanks. Oil-contaminated water from industries, municipalities and petrol stations is collected by car to Ciclean and is pumped into the receiving tanks. The oil-contaminated water from the receiving tanks is pumped into the plant and after this the pipelines are flushed with clean water, before they are drained. The oil phase that eventually is formed at the top of the recieving tanks, is transfered to the flotation tanks. Sludge from ships and the top phase from oil separaters whithin the Skarvik and Rya area are also transfered to this tank. The top phase may contain gasoline and other petrol products. In the plant the oil is separated by chemical precipitation with aluminiumsulphate. The pH is adjusted with caustic soda to 6,5. This is done atamatically and is controlled by a pH-electrode. The percipitated contaminations are flocked in the flocking tank. Polyelectrolyte is added to optimize the flocking. The cleansed water is pumped to the clean-water tank through four sand filters. Water from this tank is also used for back flushing of the sand filters. The back-flushing-water is gathered in a tank for dirty water, from where the water is pumped back to the cleaning plant. The cleansed water is later on let out in Göta älv through a control plant where the flow, pH and oil contents are registrated continuously. There are also an automatic taker of specimens situated in the control plant, which takes specimens proportional to the flow. If the incoming water does not contain emulsified oil the water is pumped to the two flotation plants. To the flotation water/air-dispersion at the preassure of 5 to 6 Bar is used. The cleansed water is pumped to the clean-water tank and later on let out in Göta älv. The sepatated oil-containing sludge from the flotation plant is pumped to the recycling tank, where it is heated to 60 deg C. The sludge is then mixed with nitric acid to get pH approx 1. This makes the oil separate from the aluminium hydroxide and float up to the surface. The oil is then noramly unloaded to ships or tankers to be transported to external, certified companies to be recycled or destroyed. The water phase, which consists of an acid aluminium sulphate solvent, is pumped back to the plant where the chemicals can be used to clean the emulcified water.

System Boundaries	
Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1993
Data Type	Unspecified

Represents	See 'Function'.
Method	Study the Environmental report. The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1993. The total received amount of oil-contaminated waste water during 1993 was 271603 m3. The companies hired to take the specimens and do the analyses are Svenska Saybolt AB, Kemanalys AB, AL Control, AB AnalyCen.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	the companies used for taking of specimens and analysing are Svenska Saybolt AB, AL Control, Kemianalys AB, Chemcontrol AB and AB AnalyCen

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1993 Data type: Unspecified Notes: The substance is used to precipitate contaminations in the water. The rest products of the substance is let out with the processing water.	Input	Refined resource	Aluminium sulphate	0.048600347			kg	Technosphere	
	Input	Refined resource	Electricity	0.000964643			MWh	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: (Lensitil BR) Used for degreasing, the rest products are let put in the waste oil.	Input	Refined resource	Emulsifier	0.001472738			kg	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: The substance is used to accomplish hydrogen sulphide reduction. The rest products of the substance is let out in the processing water.	Input	Refined resource	Hydrogen peroxide	0.001435919			kg	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: The substance is used to adjust the PH. The rest products of the substance is let out in the processing water.	Input	Refined resource	Nitric acid	0.09278248			kg	Technosphere	
	Input	Refined resource	Oil-contaminated waste water	1			m3	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: (Duromax) The substance is used as a flocculo agent. The rest products are let out in the waste oil.	Input	Refined resource	Polymers	0.002650928			kg	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: The substance is used to adjust the PH. The rest products of the substance is let out in the processing water.	Input	Refined resource	Sodium hydroxide	0.100146169			kg	Technosphere	
Date concieved: 1993 Data type: Monitored data, continuous Method: Specimens are taken continuously on the outgoing oil-contaminated waste water from Ciclean. The taking of specimens is done automatically by a machine. The specimens are stored for one week, and ones a month a specimen is anaysed. The analyses are done according to Swedish standard. The amount in the table is based on an geometric average of 12 specimens. The average is 7,4 g / m3, the minimum value 1,6 g / m3 and the maximum value was 17 g / m3. The flow of the outgoing water is monitored continuously, and the total amount is 256465 m3 during 1993. Notes: Emission in the oil-contaminated water, which is let out in Göta älv.	Output	Emission	Aromatics	0.006995504			kg	River	
Date concieved: 1993 Data type: Monitored data, continuous Method: Specimens are taken continuously on the outgoing oil-contaminated waste water from	Output	Emission	COD	0.000361925			tonne	River	

Ciclean. The taking of specimens is done automatically by a machine. The specimens are stored for one week, and ones a month a specimen is anaysed. The analyses are done according to Swedish standard. The amount in the table is based on an geometric average of 48 specimens. The average is 382 g / m3, the minimum value 41 g / m3 and the maximum value was 1600 g / m3. The flow of the outgoing water is monitored continuously, and the total amount is 256465 m3 during 1993. Notes: Emission in the oil-contaminated water, which is let out in Göta älv.									
Date concieved: 1993 Data type: Monitored data, continuous Method: Specimens are taken continuously on the outgoing oil-contaminated waste water from Ciclean. The taking of specimens is done automatically by a machine. The specimens are stored for one week, and ones a month a specimen is anaysed. The analyses are done according to Swedish standard. The amount in the table is based on an geometric average of 48 specimens. The average was 2,7 g / m3, the minimum value 0,3 g / m3 and the maximum value was 5,2 g / m3. The flow of the outgoing water is monitored continuously, and the total amount is 256465 m3 during 1993. Notes: Emission in the oil-contaminated water, which is let out in Göta älv.	Output	Emission	Mineral oil	0.001840922			kg	River	
Date concieved: 1993 Data type: Monitored data, continuous Method: Specimens are taken continuously on the outgoing oil-contaminated waste water from Ciclean. The taking of specimens is done automatically by a machine. The specimens are stored for one week, and ones a month a specimen is anaysed. The analyses are done according to Swedish standard. The amount in the table is based on an geometric average of 12 specimens. The average is 0,9 g / m3, the minimum value 0,3 g / m3 and the maximum value was 1,6 g / m3. The flow of the outgoing water is monitored continuously, and the total amount is 256465 m3 during 1993. Notes: Emission in the oil-contaminated water, which is let out in Göta älv.	Output	Emission	Phenol	0.000736369			kg	River	
Date concieved: 1993 Data type: Monitored data, continuous Method: Specimens are taken continuously on the outgoing oil-contaminated waste water from Ciclean. The taking of specimens is done automatically by a machine. The specimens are stored for one week, and ones a month a specimen is anaysed. The analyses are done according to Swedish standard. The amount in the table is based on an geometric average of 48 specimens. The average is 8,9 g / m3, the minimum value 2,7 g / m3 and the maximum value was 20 g / m3. The flow of the outgoing water is monitored continuously, and the total amount is 256465 m3 during	Output	Emission	TEX	0.008468242			kg	River	

1993. Notes: Emission in the oil-contaminated water, which is let out in Göta älv.									
Date concieved: 1993 Data type: Calculated Method: The emissions of hydrocarbons are calculated ones a year. The amount is based on measurements on the preassure of the recieved separated oil. The pressures of the separated oil are Tank 1. 6,0 kPa Tank 2. 16 kPa Tank 4. Nil kPa Notes: Emission in the oil-contaminated water, which is let out in Göta älv.	Output	Emission	Unpolar hydrocarbons	0.00198451416			kg	Water	
Date concieved: 1993 Data type: Unspecified Notes: The oil waste and sludge are transported by GRAAB-KEMI to Torsviken to be dumped.	Output	Residue	Oil waste	0.001778331			m3	Technosphere	
Date concieved: 1993 Data type: Unspecified Notes: The waste is transported to approved external receiver.	Output	Residue	Oil-contaminated waste	0.001502193			m3	Technosphere	
Date concieved: 1993 Data type: Single sample Notes: 1 m3 by Ciclean recieved oil-contaminated waste water The oil-contaminated water that comes to the company consist of: 18,6% Ballas, washing and rejected water from ships and oilcontaminated water which has been taken care of at oil disasters and such. 74,6% Oil-contaminated waste water from surface water systems. 2,23% Oil-contaminated water and sludge from ships. 0,401% Emulsions from industries, petrol stations and municipalities. 0,214% Oil-contaminated water from industries and municipalities. 3,88% Oil-contaminated water from cicterns.	Output	Residue	Oil-contaminated waste water	0.944264239			m3	River	
Date concieved: 1993 Data type: Unspecified Notes: Is shipped out or brought by car to Scanfuel/SAKAB for recycling.	Output	Residue	Waste oil	0.018895226			m3	Technosphere	

About Inventory

Publication	The environmental report from Ciclean AB for 1993, The Board of County in Göteborg and Bohus The Department of Environment --- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden.
Practitioner	Hell, Mati - CICLEAN AB Box 48047 41821 Göteborg Sweden.
Reviewer	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden
Applicability	
About Data	
Notes	

SPINE LCI dataset: Treatment of oil-contaminated waste water

Administrative	
Finished	Y
Date Completed	1999-04-15
Copyright	
Availability	Public

Technical System	
Name	Treatment of oil-contaminated waste water
Functional Unit	1 m3 of oil contaminated wastewater from the oil treatment.
Functional Unit Explanation	The water treatment facility is seen as a subsystem to the oil treatment for treatment of the oil contaminated wastewater generated at this facility. In 1997 the received water had the following origin: Industries and municipalities 600 m3 Surface water system 129 012 m3 (1101 m3 from Skarvik) Ballast- wash- and slopwater from vessels and tankers 16 811 m3 Emulsions from industries, municipalities and gas-stations 1739 m3 Cisterns 16 807 m3 (11 310 m3 from Skarvik)
Process Type	Gate to gate
Site	CICLEAN AB Box 48047 41821 Göteborg Sweden
Sector	Waste treatment
Owner	CICLEAN AB Box 48047 41821 Göteborg Sweden
Technical system description	The water treatment facility receives and treats oil-contaminated water from ships and some oil wastes and emulsions from industries in the western parts of Sweden. The waste water is first collected in tanks before filtered where the oil phase is separated from the water. The water phase undergoes two treatment steps, first a flocking tank and later sand filters, before it is let out into the recipient. The oil phase from the reception tank is treated in a settling tank where water is further separated. The cleaning process is based on chemical precipitation with aluminiumsulphate, flotation and sand filtration. The aluminiumsulphate is recycled with up to 80 % and derived oil is pumped to a storage tank for further transportation to a certified external receiver. (The transportation is not a part of the systems function.) Within the plant there are two tanks, each with a capacity of 10 000 m3, used for receiving ballast water and other oil-contaminated water, one processing tank (2000 m3), a so called settling tank used for separating oil and water and one storage tank (1500 m3) used for separated oil. The plant also has six smaller receiving tanks (2 at 230 m3 and 4 at 50 m3) to increase the facility’s flexibility and possibility for separate treatment of particularly contaminated water. Some of the receiving tanks are provided with heating and has the possibility to draft at the top. Oil-contaminated water, e.g. ballast water is pumped from ships to the receiving tanks. Oil-contaminated water from surface water systems within Skarvik- and Rya harbours is also pumped to these tanks. Oil-contaminated water from industries, municipalities and petrol stations is collected and transported by truck to the facility, where it is pumped into the receiving tanks. (The transportation is not a part of the systems function.) Scrap is derived through filtering. As the scrap is combustible it is sent to Sävenäs, a waste fuelled power plant. The oil phase, which eventually is formed at the top of the receiving tanks, is transferred to the settling tank. Sludge from ships and the top phase from oil separators within Skarvik- and Rya harbours are also transferred to this tank. The top phase may contain gasoline and other petrol products. In the settling tank water and oil are split under the influence of heat and the addition of Petrotec RI-54. The derived oil is pumped to a storage tank for further transportation to a certified external receiver. The water goes into the plant. In the plant the oil is separated by chemical precipitation with aluminiumsulphate. The pH is adjusted with caustic soda to 6,5. This is done automatically and is controlled by a pH-electrode. The precipitated contamination is flocked in the flocking tank. Polyelectrolyte (Magnaloc LT 27 AG) is added to optimise the flocking. The cleansed water is pumped to the clean-water tank through four sand filters. Water from this tank is also used for back flushing of the sand filters. The back flushing water is gathered in a tank for dirty water, from where the water is pumped back to the cleaning plant. The cleansed water is later on let out in Götaälv through a control plant where the flow, pH and oil contents are measured continuously. There is also an automatic testing device situated in the control plant, which takes specimens proportional to the flow. If the incoming water does not contain emulsified oil the water is pumped to the two flotation plants. To the flotation water/air-dispersion at the pressure of 5 to 6 bar is used. The cleansed water is pumped to the clean-water tank and later on let out in Götaälv.

	The separated oil-containing sludge from the plant is pumped to the recycling tank, where it is heated to 60ºC. The sludge is then mixed with sulphuric acid to get pH approximately to 1. This makes the oil separate from the aluminium hydroxide and float up to the surface. The oil is then send to the storage tank (see above). The water phase, which consists of an acid aluminiumsulphate-solvent, is pumped back to the plant where the chemicals can be re-used to clean the emulsified water.

System Boundaries

Nature Boundary	Resources that are not seen as limited in Sweden are neglected e.g. land usage and fresh water. The company is legislated to measure the following emissions: Mineral oil TEX (aliphatic) COD Phenol
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary set to Sweden.
Other Boundaries	Cut-off criteria The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. Is is assumed that there occurs no spill at the plant. The chemicals Magnaloc LT 27 AG and Petrotec RI-54 are accumulated in the oil. As the oil leaves as a product their impacts on the environment can not be estimated as emissions at the water treatment facility. The impact that they cause depends on how the oil is used. It is although important to keep in mind that those chemicals has contaminated the oil and should be taken under consideration when emission is calculated for combustion of the product. The oil percentage in the incoming water is thought to be so low that no sedimentation occurs in the receiving tanks. The only sedimitation that occurs at the facility is caused by the derived oil in the storage tank. Scrap derived from filtering is not taken under consideration. As the water from the oil treatment already has been filtered at this facility it is considered to be free from scrap when it is pumped to the water treatment facility. The production of electricity used in the system has not been included.
Allocations	The facility treats various kinds of water but they are all considered to have the same resource use and emission per m3. As described for the functional unit; only the resource use and emissions from treatment of the wastewater from the oil treatment facility is of interest, therefore are only those impacts accounted for.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1997
Data Type	Unspecified
Represents	See 'Function'.
Method	Data are acquired from study of the environmental report of 1997 and inquires to the employees at the facility. Emissions of hevy metals are modelled from data in the environmental report for Reci Halmstad. This is done due to unsufficient data about these emissions. The modelled data has been taken from the incoming water to the water treatment. Companies hired for analysing the specimens taken are; Svenska Saybolt AB, Kemanalys AB and Analycen AB. The subtances are divided with the total amount of recieved oil-contaminated water (164 969 m3) to represent amount per functional unit.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	the companies used for taking of specimens and analysing are Svenska Saybolt AB, AL Control, Kemianalys AB, Chemcontrol AB and AB AnalyCen

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Data type: Economical information Method: Total amount used 8325 kg. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: In the plant oil is separated by chemical precipitation with aluminium sulphate.	Input	Refined resource	Aluminium sulphate	0.051			kg	Technosphere	Sweden

Date concieved: 1997 Data type: Economical information Method: Total electricity used 229 MWh. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: Delivered by Göteborgs Energi.	Input	Refined resource	Electricity	1.397			kWh	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Total use 12060 kg H2SO4 (96%). Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: The substance is used at the recycling tank. Sulphuric acid is mixed with the sludge to get a pH level of approximately 1. This makes the oil separate from the aluminium hydroxide.	Input	Refined resource	H2SO4	0.074			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Total amount used 775 kg. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: The polyelectrolyte Magnafloc LT 27 AG is added to optimise the flocking. It is supposed to leave with the treated waste oil. Retailer: CDM AB Box 37 421 21 Västra Frölunda phone: +46 -31 89 39 00 Contents: Akrylamid Water Copolymer	Input	Refined resource	Magnafloc LT 27 AG	0.0047			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Totally used 15640 kg. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: The caustic soda (NaOH) is used to adjust the pH-level.	Input	Refined resource	NaOH	0.0954			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Monitored data, continuous Method: The inflow to the reception tanks are continuously measured and recorded. (Christian Artén) Literature: The environmental report for Reci Industri Ciclean Dennis Göthe process engineer Ciclean. Christian Artén process engineer Skarvik. Notes: Oil-contaminated water from cisterns and the surface water system at the Skarsvik facility. (Dennis Göthe) Total amount delivered, 164 969 m3 (Skarvik included) From Skarvik total, 12 411 m3 (Environmental report)	Input	Refined resource	Oil-contaminated waste water	1			m3	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Total amount used 200 kg. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: The demulgator (Petrotec RI-54) is used in the settling tank to split water and oil. The substance is supposed to leave with the waste oil. Producer: Petrolite Ltd Kirkby Bank Road Knowsley Industrial Park (north) Liverpool L33 7 SY Contents: Aromatic naphta 25-35% Isopropanol 0-1% Dialkyl phenol etoxylate 60-70% Alkyl-aryl-sulphonates 1-3%	Input	Refined resource	Petrotec RI-54	0.0012			kg	Technosphere	Sweden
Date concieved: 1997 Data type: Economical information Method: Total energy delivered 1061 MWh. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: Heat water delivered by Göteborgs Hamn.	Input	Refined resource	Thermal energy	6.471			kWh	Technosphere	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on the use of aluminiumsulphate. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: Emission in the treated water, which is let out in Göta älv.	Output	Emission	Aluminium sulphate	0.0508			kg	Ocean	Sweden
Date concieved: 1997 Data type: Monitored data, continuous Method: Specimens proportional to the flow are taken continuously on the outgoing water from the water treatment facility. The taking of specimens is done automatically by a machine. Once a month a representative sample for the month is analysed at an external laboratory. (Document G 231_01) The amount in the table is	Output	Emission	AOX	0.1586			g	Ocean	Sweden

based on an geometric average of 10 specimens. The average is 0,18 g / m3, the minimum value 0,07 g / m3 and the maximum value was 0,3 g / m3. The flow of the outgoing water is monitored continuously, and the total amount was 158 214 m3 during 1997. (Environmental report) Literature: The environmental report of 1997 for Reci Industri Ciclean. Document G 231_01 for sample taking at Reci Industri AB. Notes: AOX, halogen. Emission in the treated water, which is let out in Göta älv.									
Date concieved: 1997 Data type: Monitored data, continuous Method: Specimens are taken continuously on the outgoing water from the water treatment facility. The taking of specimens is done automatically by a machine. The specimens are mixed representatively and are analysed weekly at an external laboratory. (Document G 231_01) The amount in the table is based on a geometric average of 37 specimens. The average is < 2,0 g / m3, the minimum value 0,5 g / m3 and the maximum value was 6,8 g / m3. The flow of the outgoing water is monitored continuously, and the total amount was 158214 m3 during 1997. (Environmental report) Literature: The environmental report of 1997 for Reci Industri Ciclean. Document G 231_01 for sample taking at Reci Industri Göteborg Notes: Emission in the treatad water, which is let out in Göta älv.	Output	Emission	Aromatics	1.8296			g	Ocean	Sweden
Date concieved: 1997 Data type: Estimated from similarity Represents: Reci Industri AB Halmstad Method: Data are modelled from the environmental report for Reci Halmstad of 1997. This is done due to that no data about the emission is presented for Reci Göteborg. Reci Halmstad is a similar plant but with a better water treatment facility. The modelled data are based on the incoming water and the assumption that the facilities have the same amount of heavy metals per m3 wastewater. Amount of cadmium per m3 incoming water in Halmstad: 0,0020 g Amount of treated water at Ciclean: 163 969 m3 Amount emitted Cd at Reci Göteborg: 163 969*0,0020 = 327.938 g Literature: The environmental report of 1997 for Reci Industri Halmstad. Notes: Emission in the treated water, which is let out in Göta älv.	Output	Emission	Cd	0.002			g	Ocean	Sweden
Date concieved: 1997 Data type: Monitored data, continuous Method: Specimens are taken continuously on the outgoing water from Ciclean. The taking of specimens is done automatically by a machine. The specimens are mixed representatively and are analysed weekly at an external laboratory. The amount in the table is based on a geometric average of 37 specimens. The average is 637 g / m3, the minimum value 101 g / m3 and the maximum value was 2800 g / m3. The flow of the outgoing water is monitored continuously, and the total amount was 158214 m3 during 1997. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: Emission in the treated water, which is let out in Göta älv.	Output	Emission	COD	615.97			g	Ocean	Sweden
Date concieved: 1997 Data type: Estimated from similarity Represents: Reci Industri AB Halmstad Method: Data are modelled from the environmental report for Reci Halmstad of 1997. This is done due to that no data is presented about the emission at Reci Göteborg. Reci Halmstad is a similar plant but with a better water treatment facility. The modelled data are based on the incoming water and the assumption that the facilities have the same amount of heavy metals per m3	Output	Emission	Cr	0.049			g	Ocean	Sweden

wastewater. Amount of Cr per m3 incoming water in Halmstad: 0,049 g Amount of treated water at Ciclean: 163 969 m3 Amount emitted Cr at Reci Göteborg: 163 969*0,049 = 8 034,481 g Literature: The environmental report of 1997 for Reci Industri Halmstad. Notes: Emission in the treated water, which is let out in Göta älv.									
Date concieved: 1997 Data type: Calculated Method: Based on the use of H2SO4. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: Emission in the treated water, which is let out in Göta älv.	Output	Emission	H2SO4	0.0706			kg	Ocean	Sweden
Date concieved: 1997 Data type: Unspecified, expert outspoke Method: The emission is estimated to about 6 ton/year based on the pressure in the oil cisterns. Hydrocarbons are emitted to the air by tank breathing. Literature: Mati Hell, innovation engineer Reci Industri Göteborg. Notes: Emission to the air from the oil tanks.	Output	Emission	HC	36.59			g	Air	Sweden
Date concieved: 1997 Data type: Monitored data, continuous Method: Specimens are taken continuously on the outgoing water from Ciclean. The taking of specimens is done automatically by a machine. The specimens are mixed representatively and analysed weekly at an external laboratory.(Document G231_01) The amount in the table is based on an geometric average of 37 specimens. The average was 3.3 g / m3, the minimum value 0.5 g / m3 and the maximum value was 35 g / m3. The flow of the outgoing water is monitored continuously, and the total amount was 158 214 m3 during 1997. (Environmental report) Literature: The environmental report of 1997 for Reci Industri Ciclean. Document G231_01 for sample taking at Reci Industri AB. Notes: Emission in the treated water, which is let out in Göta älv.	Output	Emission	Mineral oil	3.049			g	Ocean	Sweden
Date concieved: 1997 Data type: Calculated Method: Based on the resource use. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: Emission in the treated water, which is let out in Göta älv. All the NaOH is supposed to leave with the treated water.	Output	Emission	NaOH	0.0954			kg	Ocean	Sweden
Date concieved: 1997 Data type: Unspecified Method: Data are modelled from the environmental report for Reci Halmstad of 1997. This is done due to that no data is presented about the emission at Reci Göteborg. Reci Halmstad is a similar plant but with a better water treatment facility. The modelled data are based on the incoming water and the assumption that the facilities have the same amount of heavy metals per m3 wastewater. Amount of Ni per m3 incoming water in Halmstad: 1,0 g Amount of treated water at Ciclean: 163 969 m3 Amount emitted Ni at Reci Göteborg: 163 969*1,0 = 163 969 g Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: Emission in the treated water, which is let out in Göta älv.	Output	Emission	Ni	1.0			g	Ocean	Sweden
Date concieved: 1997 Data type: Estimated from similarity Represents: Reci Industri AB Halmstad Method: Data are modelled from the environmental report for Reci Halmstad of 1997. This is done due to that no data the emission is presented for Reci Göteborg. Reci Halmstad is a similar plant but with a better water treatment facility. The modelled data are based on the incoming water and the assumption that the facilities have the same amount	Output	Emission	Pb	0.01			g	Ocean	Sweden

of heavy metals per m3 wastewater. Amount of Pb per m3 incoming water in Halmstad: <0,01 g Amount of treated water at Ciclean: 163 969 m3 Amount emitted Pb at Reci Göteborg: 163 969*0,01 = <1 639,69 g Literature: The environmental report of 1997 for Reci Industri Halmstad. Notes: Emission in the treated water, which is let out in Göta älv.									
Date concieved: 1997 Data type: Monitored data, continuous Method: Specimens are taken continuously on the outgoing water from the water treatment facility. The taking of specimens is done automatically by a machine. The specimens are mixed representatively and analysed weekly at an external laboratory. (Document G231_01) The amount in the table is based on an geometric average of 37 specimens. The average is less than 0,9 g / m3, the minimum value 0,20 g / m3 and the maximum value was 5,5 g / m3. The flow of the outgoing water is monitored continuously, and the total amount is 158 214 m3 during 1997. (Environmental report) Literature: The environmental report of 1997 for Reci Industri Ciclean. Document G231_01 for sample taking at Reci Industri AB Notes: Emission in the oil-contaminated water, which is let out in Göta älv.	Output	Emission	Phenol	0.9148			g	Ocean	Sweden
Date concieved: 1997 Data type: Monitored data, continuous Method: Specimens are taken continuously on the outgoing water from Ciclean. The taking of specimens is done automatically by a machine. The specimens are mixed representatively and analysed weekly at an external laboratory. The amount in the table is based on a geometric average of 37 specimens. The average is 13 g / m3, the minimum value 2,9 g / m3 and the maximum value was 50 g / m3. The flow of the outgoing water is monitored continuously, and the total amount was 158 214 m3 during 1997. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: TEX (aliphatic) assumed to represent the amount of aliphatic hydrocarbons. Emission in the treated water, which is let out in Göta älv.	Output	Emission	TEX (aliphatic)	12.197			g	Ocean	Sweden
Date concieved: 1997 Data type: Estimated from similarity Represents: Reci Industri AB Halmstad Method: Data are modelled from the environmental report for Reci Halmstad of 1997. This is done due to that no data about the emission is presented for Reci Göteborg. Reci Halmstad is a similar plant but with a better water treatment facility. The modelled data are based on the incoming water and the assumption that the facilities have the same amount of heavy metals per m3 wastewater. Amount of Zn per m3 incoming water in Halmstad: 1,0 g Amount of treated water at Ciclean: 163 969 m3 Amount emitted Zn at Reci Göteborg: 163 969*1,0 = <163 969 g Literature: The environmental report of 1997 for Reci Industri Halmstad. Notes: Emission in the treated water, which is let out in Göta älv.	Output	Emission	Zn	1.0			g	Ocean	Sweden
Date concieved: 1997 Data type: Economical information Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: Shipped out to Reci Halmstad for recycling.	Output	Product	Waste oil	0.03			m3	Technosphere	Sweden
Date concieved: 1997 Data type: Monitored data, continuous Method: The outflow is continuously measured and recorded. The recorded outflows are summated and presented in the environmental report. Literature: The environmental report of 1997 for Reci Industri Ciclean. Notes: The water undergoes controls of the amount of some pollutants and then	Output	Product	Water	0.9698			m3	Ocean	Sweden

let out in Göta älv.									
Date concieved: 1997 Data type: Unspecified Method: Inquiry with the production manager at Reci Halmstad, Bengt Borg. The waste oil is supposed to cause a sedimentation of 0,25% at Reci´s facility in Halmstad. The data is supposed to be representative for the sedimentation at Ciclean as well, calculated on the amount of extracted oil (waste oil). Literature: Bengt Borg, production manager at Reci Industri Halmstad. Notes: The oil sludge, caused by sedimentation in the oil storage tank, is derived when the tank is cleansed. As this is not an every-year-procedure the amount of sediment per cubic metre is estimated as above. The oil sludge is transported to SAKAB for destruction.	Output	Residue	Oil-sludge	0.0001			m3	Technosphere	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology -- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally the result is a part of Reci's ISO 14000 certification, which acts as a guarantee to the customers. The quality of the inquiry is set due to the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emissions released treating oil contaminated water.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data represented are site-specific and are only valid for treatment of wastewater from Skarvik. As the incoming water is of very varying composition and quantity the impact per functional unit may vary quite much. The data shall therefore be seen as estimation of the impacts made. The chemicals Magnaloc LT 27 AG and Petrotec RI-54 are accumulated in the oil. As the oil leaves as a product their impacts on the environment can not be estimated as emissions at the water treatment facility. The impact that they cause depends on how the oil is used. It is although important to keep in mind that those chemicals has contaminated the oil and should be taken under consideration when emission is calculated for combustion of the product.
About Data	The oil-sludge, caused by sedimentation in the oil storage tank, is derived when the tank is cleansed. As this is not an every-year-procedure the amount of sediment per cubic metre has to be estimated. The waste-oil is supposed to cause sedimentation of 0,25% at Reci's facility in Halmstad. The data is supposed to be representative for the sedimentation at Reci Göteborg as well, calculated on the amount of treated oil. Mass balance Input approximately 165 000 m3. Output about 163 200 m3. Difference 1800 m3. When put into perspective of the total inflow the difference can be assumed to be a measurement error. As the treatment of oil-contaminated water is a continual process and flows are only measured when entering or leaving the system it is also plausible that an significant volume was still in the system when inflows and outflows where reported. The most likely explanation is a measurement error on the inflow and outflow of water. The total inflow was 164 969 m3and the total outflow 158 214 m3. To achieve mass balance the inflow is supposed to be 1000 m3 lesser and the outflow 800 m3 more.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Treatment of sewage

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Treatment of sewage
Functional Unit	m3
Functional Unit Explanation	1 m3 sewage that has come to the works to be cleansed.
Process Type	Gate to gate
Site	GRYAAB Karl IX:s väg 418 34 Göteborg Sweden
Sector	Waste treatment
Owner	GRYAAB Karl IX:s väg 418 34 Göteborg Sweden
Technical system description	The process consist of 1. sewage and sludge treatment at Ryaverket 2. sludge treatment and dumping in the rock shelter at Syrhåla 3. sludge combustion at Tankgatan. GRYAAB takes care of the sewage in the region of Gothenburg. It is owned by the municipality of Ale, Göteborg, Härryda, Kungälv, Lerum, Mölndal and Partille. Approximatly 11% of the incoming sewage comes from the industry, medical service and public administration. The rest comes from households, except for the sewage from 3000 companies. The companies sewage differs in some ways from household sewage, but is not classed as industrial sewage. The recipient for the cleansed water is Göta älv. 1. Ryaverket is built to take care of sewage from 680 000 people. At Ryaverket the sewage is cleaned (a) physically, (b) chemically and (c) biologically. (a) The incoming sewage is pumped in to the sewage treatment works. The intake is covered with grating. The sewage is then distributed to 12 different pre sediment reservoirs. The solid particles are removed here. (b) The sewage is pumped to the airing reservoirs, where active dredge, consisting of bacteria and other micro organisms, is mixied with it. When the water is aired some of the contamination is ''eaten'' by the bacteria. After approximately 2 h the water is led to the post sediment reservoirs. In the reservoirs the active sludge is sedimented and seperated from the water. The greater part of the sedimented sludge is pumped back to the airing reservoirs to be used again, the rest is cleansed. Some of the energy that is used to pump the water is gained by letting the water pass through a turbine at the outlet. (c) Irondisulphate is used to precipitate phosphorus. The irondisulphate is dosed at the inlet or in the pre sediment reservoir. The dosage is 1,0-1,3 mole iron per mole phosphorus.The precipitated ironphosphate is corporated in the active sludge flocks. Sludge treatment at Ryaverket Particles greater than 3 mm (in diameter) are removed from the dredge. The sludge is thickened. In a digester plant the bacteria transform the decomposable parts of the dredge. This is done in an anaerobic environment. At the breaking down energenic biogas is made. The gas consists of 60-65% marsh gas and 35-40% carbondioxide. Due to the fact that the organic materials is broken down the treated sludge is almost odourless, compared with the untreated sludge. The biogas plant consists of two digesters, one slam silo and equipment for energy recycling and the handling of gas. The foot-outlet of the four dredge thickener four pumps pump the thickened dredge to the digesters. On the way in to the digester the heat from the outgoing sludge is exchanged to the ingoing. In this way 50% of the energy used to warm the sludge it saved. The Ryaverk is also able to receive external organic material, like food left-overs, fat, and such from restaurants and so on. This is dygested with the sludge to increase the production of biogas. The digesters keep a temperature of 37 °C because the slugde is circulated trough a heat exchanger where the sludge is heated by hot water. The sludge is digested for approx.15 days. In the degas chamber air is blown through the digested sludge, which stops the digesting process. The sludge is then dewatered and is eventually

	stored in rock shelters. Certain sludge can be used as fertilizer. Sometimes lime is added to the sludge. Waste, which has been removed from the sewage in the cleaning process is dumped at Tagene. Building material is dumped at Tagene or Gunnilse. The material that is recycleble, is recycled and the small quantities of waste that is hazardous to the environment is sent to Reci Industri AB. 2. The sludge is dewatered and stored in rock shelters. In the storage process gas is produced. Some is used in the Ryaverk for heating, and some is directly combusted. 3. Some of the sludge is mixed with bark and composted for 5-8 weeks.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	The municipal of Ale, Göteborg, Härryda, Kungälv, Mölndal and Partille, Sweden.
Other Boundaries	The energy that is both produced and consumed in the plant is not shown in the flow table, though the emissions caused is taken into account.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	
Method	Studying the environmental report. The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1996, which was 104,1 Mm3.
Literature Reference	The Environmental Report from GRYAAB for 1996, The Environmental Administration in the municipality of Göteborg.
Notes	The data type unspecified implies that one does not know the origin of the data. The method for taking the spiecements of water and dredge is described under Specific QMetaData for AOX. The method for analysing the spieciment is presented for each emitted substance on specific QMetaData/method.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1996	Input	Natural resource	Water	0.002537944			tonne	Water	
Date concieved: 1996 Data type: Unspecified Notes: The butric oil is based on petrolium and is used as lubricating oil for machine parts. It is recycled. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	Butric oil	0.0000000539866			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consist of 99% NaOH and is used in the laboratory. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	Caustic soda	0.000000000230548			m3	Technosphere	
	Input	Refined resource	Diesel	0.000000139289			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Method: From the	Input	Refined resource	Electricity	1.152737752161E-07			GWh	Technosphere	

environmental report one can find the flows of electricity. The amount in the table shows the difference between the amount of used and produced electricity. Ryaverket and the Biogas plant used 26,3 GWh electricity. Syrhåla used 614 MWh electricity. 14,25 GWh electricity is produced in the sewage treatment works, 13,75 GWh is produced in the biogas engine and 0,5 GWh by the water driven turbine. Notes:									
	Input	Refined resource	Fuel gas	2.593659942363E-09			GWh	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: 98% H2SO4 The acid is used in the lamoratory. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	H2SO4	9.60615E-11			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: 37% HCl Used in the laboratory. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	HCl	0.00000000115274			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The product name is Quickfloc. FeSO4*7H2O (crystals) 90% and water 10%. Used to clean the water from phosphorus. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	Iron sulphate	0.0000617771			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The sewage treatment plant states that they use lime but not how much. Lime is used in the form of limestone meal and burnt lime to improve the physical qualities of the dredge. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	Lime	0			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: LiCl 99%.	Input	Refined resource	Lithiumchloride	0.00000000288184			tonne	Technosphere	

LiCl is a trace element. The data type unspecified implies that one does not know the origin of the data.									
Date concieved: 1996 Data type: Unspecified Notes: This subject comes with the ironsulphate. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	Ni	0.00000000153698			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: This substance comes with the ironsulphate. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	Pb	0.000000000345489			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The polymers consist of DP7-6129A (2,9E-7 ton) and Duromax floc AN (2,3E-7 ton). It is used for flocking. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	Polymers	0.000000524496			tonne	Technosphere	
Date concieved: 1996 Data type: Monitored data, continuous Method: The flow is measured continiously, and the day average is 3,27 m3/s. According to the sewage treatment works (Ryaverket) the margin of error does not exceed 5%. Notes: Average values from taking samples during 1996 shows that 1 m3 of the incoming sewage contains (compare with the outgoing water, see Specific QMetaData under Product Water): Average flow (24 h) 3,27 m3/s P-tot 5,41 g Chemical consumption of oxygen 370 g O2 Biological consumption of oxygen 151 g O2 N-tot 31,4 g Ammoniumnitrogen 21,4 g N Hg 0,32<>0,36 mg Cd 0,41 mg Pb 8 mg Cu 79 mg Cr 10 mg Ni 15 mg Zn 0,12 g AOX 0,12 g Polar carbonhydrogen (oil+fat) 10,6 g Unpolar carbonhydrogen	Input	Refined resource	Sewage	1			m3	Technosphere	

(oil) 0,47<>0,53 g									
Date concieved: 1996 Data type: Unspecified Notes: NaClO, 12% free Cl. Used for disinfection. It is delivered to Ryaverket by tank lorry and pumped to a storage tank at the plant. Any spillage that occurs is led to the internal sewage system. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	Sodium hypochlorite	0.00000182517			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: This substance comes with the ironsulphate. The data type unspecified implies that one does not know the origin of the data.	Input	Refined resource	Zn	0.0000000018732			tonne	Technosphere	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to the sewage treatment works (Ryaverket) the margin of error does not exceed 5%. The taking of speicements is proportional to the flow of the water.The measuring instruments are clensed every day, both mechanically (brushing) and chemically (3 M HCl). The employees that takes the speicements are trained externally. KM-Lab in Uddevalla is hired to analyse the dredge and Göteborgs VA-verkets laboratorium in Lackarebäck is hired to make the water analyses. The analyse method used has the code AOX ss 028104 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by KM-Lab, Uddevalla. Notes: The recipient is Göta älv (river).	Output	Emission	AOX	0.0000000576369			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code	Output	Emission	BOD	0.0000212776			tonne	Water	

BOD7-NAE ss 028143-2 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by VA-verkats laboratorium, Lackarebäck.									
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code CD-NG ss 028152-2 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by VA-verkats laboratorium, Lackarebäck.	Output	Emission	Cd	2.88184e-10	1.2488e-10	1.63305e-10	tonne	Water	
	Output	Emission	CO2	0.00000485283			tonne	Air	
Date concieved: 1996 Data type: Random samples Method: The analyse method used has the code CODCR ss 028142-2 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by VA-verkats laboratorium, Lackarebäck.	Output	Emission	COD	0.000073487			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code CR-NG ss 028152-2 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by VA-verkats laboratorium, Lackarebäck.	Output	Emission	Cr	9.94236e-9	4.65898e-9	5.28338e-9	tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code CU-NG ss 028152-2 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by VA-verkats laboratorium, Lackarebäck.	Output	Emission	Cu	0.000000015658			tonne	Water	

Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code HG-A ss 028175-1 (hydrid additive) according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by VA-verkats laboratorium, Lackarebäck.	Output	Emission	Hg	3.7464e-10	1.2488e-10	2.4976e-10	tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code NI-NG ss 028152-2 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by VA-verkats laboratorium, Lackarebäck.	Output	Emission	Ni	0.00000001244			tonne	Water	
	Output	Emission	NOx	0.0000000972142			tonne	Air	
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code NTOT FIA Tecator Fiastar. The analyse is done by VA-verkats laboratorium, Lackarebäck.	Output	Emission	N-tot	0.0000227666			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code PB-NG ss 028152-2 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by VA-verkats laboratorium, Lackarebäck.	Output	Emission	Pb	3.80403e-9	6.91643e-10	3.11239e-9	tonne	Water	

Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code ORGK-TI ss 028145-3 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by KM-Lab, Uddevalla. Notes: Consist of oil and fat	Output	Emission	Polar carbonhydrogen	0.000000470701			tonne	Water		
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code PTOT-NAP ss 028172 (modified) according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by VA-verkets laboratorium, Lackarebäck.	Output	Emission	P-tot	0.000000730067			tonne	Water		
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code TS-STM. The analyse is done by KM-Lab, Uddevalla/Uppsala.	Output	Emission	Susp solids	0.0000201729			tonne	Water		
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code ORGK-O1 ss 028145-3 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by KM-Lab, Uddevalla. Notes: Consist of oil	Output	Emission	Unpolar carbonhydrogen	0.000000163305			tonne	Water		
Date concieved: 1996 Data type: Monitored data, discrete Method: The analyse method used has the code ZN-NG ss 028152-2 according to Swedish standard developed by The Swedish Environmental Protection Agancy. The analyse is done by VA-verkats laboratorium, Lackarebäck.	Output	Emission	Zn	1.92123e-8	9.60615e-9	2.88184e-8	tonne	Water		

Date concieved: 1996 Data type: Economical information Notes: Heat produced from biogas is sold to the district heating power plant Göteborgs energi.	Output	Product	Thermal energy	3.073967339097E-08			GWh	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The data type unspecified implies that one does not know the origin of the data. Average values from taking samples during 1996 shows that 1 m3 of the outgoing water contains (compare with the incoming sewage, see Specific QMetaData under Resource Sewage): Average flow (24 h) 2,96 m3/s P-tot 0,60 g Chemical consumption of oxygen 69 g O2 Biological consumption of oxygen 18 g O2 N-tot 24,1 g Ammoniumnitrogen 21,6 g N Hg 0,09<>0,22 mg Cd 0,08<>0,12 mg Pb 0,3<>2,9 mg Cu 14 mg Cr 3,4<>4,1 mg Ni 12 mg Zn 0,01<>0,03 g AOX 0,06 g Polar hydrocarbons (oil+fat) 0,5 g Unpolar hydrocarbons (oil) 0,05<>0,19 g	Output	Product	Water	0.969260326609			m3	Water	
Date concieved: 1996 Data type: Unspecified Notes: The waste is transported by Gamlestadens LC and dumped at Tagene.	Output	Residue	Building waste	0.00000268972			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Conbustable waste is transporten by Ragn Sells/the sewage treatment works and is conbusted at Sävenäs.	Output	Residue	Combustible waste	0.000961095101			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Combustible waste is transported by Ragn Sells/The sewage treatment works and combusted at Sävenäs.	Output	Residue	Combustible waste	0.471805956			g	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The concrete is transported by	Output	Residue	Concrete	0.00528049952			l	Technosphere	

Galmlestadenbs LC and dumped at Torslanda.									
Date concieved: 1996 Data type: Unspecified Notes: Excavated material is transported by Gamlestadens LC to Skarvik.	Output	Residue	Excavated material	0.00479442843			l	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The waste is transported by Ahlsell and recycled at Bjärstad Återvinning AB.	Output	Residue	Fluorescent lamp	0.0000000576369			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The other rest products consist of objects cleansed out of the sewage (also contains water and sludge) The waste is transported by the sewage treatment works and dumped at Tagene	Output	Residue	Other rest products	21.8520653218			g	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Sand and gravel is transported by Ragn Sells Agro and dumped at Gunnilsetippen.	Output	Residue	Sand and gravel	2.50802113352			g	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The scrap-metal is recycled at Stena Metal.	Output	Residue	Scrap-metal	1.6554224754			g	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The sludge consist of Dry substances 94,5% N 2,81% P 2,48147% Zn 0,0610% Cu 0,0443% Ni 0,00000242% Pb 0,000000403% Cr 0,0000000436% Cd 0,0000000152% Hg 0,0000000132% 0,138% is unspecified but one can assume that this is mainly water KM-Lab in Uddevalla/Uppsala has analysed the substances according to the following codes: Dry substances TS-STM N NTOT-NDK P PTOTM Zn ZN-AIM Cu CU-AIM Ni NI-AIM Pb PB-AIM Cr CR-AIM Cd CD-AIM Hg HG-AVM The sludge is stored (1,28%), dumped (0,884%),	Output	Residue	Sludge	527.202954			g	Technosphere	

composted at Tankgatan (28,1%) or used for landfilling (69,4%).									
Date concieved: 1996 Data type: Unspecified Notes: The waste paper is transported by Rang Sells and is recycled.	Output	Residue	Waste paper	0.00000012488			tonne	Technosphere	

About Inventory	
Publication	The environmental report from GRYAAB for 1997, the Environmental Administration at the municipal of Göteborg. -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Robinsson, Peter - GRYAAB Karl IX:s väg 418 34 Göteborg Sweden.
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.
Applicability	In some cases it can seem more efficient to look at the environmental load per amount cleansed water. It is then neccesary to know that 1 m3 sewage equals to 0,969260326609 m3, in the sewage treatment works, cleansed water. In the table, under specific QMetaData for Sewage (Resource) and Water (Product) the amount of contaminations are shown, so a comparison between the incoming sewage and the outgoing water can be made. Ryaverket is built to take care of sewage from 680 000 people.
About Data	In regard to the contamination of BOD(7) the actual load on the works is equivalent to the amount of sewage from 613 000 persons (582 000 excl. internal recirculation). This means a maximum flow of 4 m3/s. The total amount of sewage received at Ryaverket 1996 was 104,1 Mm3. The municipals that delivers sewage to Ryaverket contributes with the following percentages: Ale 2,1%, Göteborg 80,7%, Härryda 2,7%, Kungälv 2,5%, Mölndal 8,7% and Partille 3,3%. Energy The energy that is both produced and consumed in the plant is not shown in the flow table, though the emissions caused is taken into account. The energy flows are Total amount produced biogas 45,953 GWh Total amount produced electricity from water turbine 0,50 GWh City gas (bought) 0,27 GWh Total amount bought electricity 12 GWh Total amount used biogas 22,953 GWh Total amount wasted biogas (torch) 2,8 GWh Total amount of used electricity produced from biogas 13,75 GWh Total amount of used electricity (bought) 12,664 GWh Total amount of sold heat (district heating) 3,2 GWh Total amount of biogas used to run motor vehicles 0,125 GWh Energy waste 6 GWh After adding the produced and used energy, one notice that it does not sum up. The result is -2,769 GWh. Water The water that comes from the dewatering process at Syrhåla and Ryaverket is led back to the inflow of the sewage treatment works. During 1996 the recirculated water amounts to 2,48 Mm3, which is included in the total calculated inflow (104,1 Mm3).
Notes	

SPINE LCI dataset: Tree plant nursing

Administrative	
Finished	Y
Date Completed	1994-02-24
Copyright	None
Availability	Public

Technical System	
Name	Tree plant nursing
Functional Unit	1000 p
Functional Unit Explanation	1000 pieces of tree plants
Process Type	Gate to gate
Site	Middle Sweden
Sector	Forestry
Owner	Middle Sweden
Technical system description	From collected seed, plants are nursed in special green houses. This includes peat handling and sowing, internal transports, breeding in greenhouse, breeding in open air, and finally packing. Peat handling and sowing is done by two el. machines (6 kW and 50% utilisation), sowing the seed in a peat filled plastic case. 5 plastic cases per 1000 plants are used 4 times before wasted. Transport of tree plants to greenhouse by tractor (60 kW and 50% utilisation). Breeding in greenhouse includes lightning and heating. Dimensions of the greenhouse: 2000 m2 and 8 m high. Capacity: 1500000 plants per greenhouse. The greenhouse is heated by combusting diesel oil. Transport from the greenhouse to outside cultivation. Transport of tree plant to packaging room. Packing of plants is conducted by a el. machine into cardboard boxes (6 kW) Assuming the same kind of fertilizer as in fertilizing of forest: SKOG-CAN 27,2% N

System Boundaries	
Nature Boundary	Emissions caused by combustion of fuels is not included.
Time Boundary	The data collected are representative for the time period 1992-1994.
Geographical Boundary	Central Sweden.
Other Boundaries	The use of cardboard boxes is not included.
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1994-02-24
Data Type	Unspecified, expert outspoke
Represents	
Method	Information supplied by Stellan Jägermyr, Sjögrånds plantskola, Hagfors. For more information see specific QMetaData for each flow.
Literature Reference	
Notes	

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Transport to greenhouse: Tractoreffect 60 KW, 50% efficiency. 120 000 plants/h gives the distribution energy per 1000 plants = 0,9 MJ. Cultivating in greenhouse: 400 m3 diesel oil is used for heating 18 million plants annually.Thus 791 MJ/1000 plants if 35,6 MJ/l diesel. Transport to and back from outside cultivating: Same as transport to greenhouse, but twice. 2*0,9 MJ = 1,8 MJ. Uncertainy is estimated by G. Swan Source: Jägermyr, Stellan, Hagfors	Input	Refined resource	Diesel	794	640	970	MJ	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Peat handling and sowing: Two electrical veheicles (6 kW and 50% efficiency) work 100 m2/h à 800 plants/m2, resulting in 0,08 kWh/1000 plants. Cultivating in greenhouse: Totally 271300 kWh is used for illuminating 18 million plants, resulting in 15,1 kWh/1000 plants. Packing of plants: 6 kW/40 m2 per h à 800 plants per m2 resulting in 0,19 kWh/1000 plants. Uncertainy is estimated by G. Swan Source: Jägermyr, Stellan, Hagfors	Input	Refined resource	Electricity	15.3	10	20	kWh	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Cultivating in greenhouse: 5 plastic cases per 1000 plants are used 4 times before wasted.	Input	Refined resource	HDPE	1.25			kg	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Assuming the same kind of fertilizer as in fertilizing of forest: SKOG-CAN 27,2% N	Input	Refined resource	Nitrogen fertiliser	0.4			kg	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Unspecified peat	Input	Refined resource	Peat	15			kg	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke Method: Unspecified tree seed Notes: The collection and refinement of tree seeds is not included in the study.	Input	Refined resource	Tree seeds	0.25			kg	Technosphere	Sweden
Date concieved: 1994-02-24 Data type: Unspecified, expert outspoke	Output	Product	Tree plants	1000			pce	Technosphere	Sweden

About Inventory

Publication	None -- Data documented by: Göran Swan, Ola Svending, STORA Corporate Research Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	The purpose is to supply with LCA-data for forestry to be used in further studies of wood products.
Detailed Purpose	These data are an update of earlier data on the same subject. To be used in LCA representing the plant nursing part of forestry in central Sweden. Can also be used as an average for Sweden.
Commissioner	- Stora Corporate Research, Box 601 661 29 Säffle Sweden.
Practitioner	Swan, Göran - Stora Corporate Research, Box 601, S-661 29 Säffle, Sweden.
Reviewer	Brindbergs, Mats - Stora Skog, Åsgatan 22, S-79180 Falun, Sweden
Applicability	These data are valid for large scale nursery in forestry. It is important to check the type of fuel used. In this case, fossil fuel is assumed to be used. Other data is available from other forest companies, or from Skogforsk, or STFI. The silviculture process in Sweden has eight steps:

	1. Plant nursing 2. Soil preparation 3. Planting 4. Clearing 5. Thinning 6. Fertilizing 7. Final felling 8. Forwarding This is the first step.
About Data	If an average for other parts of Sweden is desired, a different amount of energy for heating may be used.
Notes	N/A

SPINE LCI dataset: Truck chassi manufacturing. ESA-DBP

Administrative	
Finished	Y
Date Completed	2001
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Truck chassi manufacturing. ESA-DBP
Functional Unit	One chassi á 5275 kg.
Functional Unit Explanation	See 'Function'.
Process Type	Gate to gate
Site	Unknown
Sector	Machinery and equipment
Owner	Unknown
Technical system description	Excerpt from the report, see 'Publication': ''The truck chassis are manufactured by Volvo AB and the model is FL6E. One chassis weighs 5275 kg and consists of several materials, mainly iron and steel. Volvo has previously performed an LCA of two heavier truck models, FH12 and FM12, and presented the results as an environmental product declaration (Volvo AB, 2001). An LCA practitioner at Volvo (R. Svensson, personal communication) helped downscaling the material content of these trucks into quantities relevant to the FL6 model, according to materials in the main parts of a truck. The results, after some aggregations of similar materials, are given in Table 3. Table 3. Materials in a FL6 chassis. Material Weight [kg] Iron and steel 3991 Aluminium 150 Lead battery 122.6 Copper, brass and bronze 62.7 Plastics 295.4 Rubber (mainly tires) 438 Glass 48.6 Textile, other fibres 22.8 Paint 8.1 Oil, grease and bitumen 55.1 Wood 0.3 Cooling agent R134a 1.0 Glycol 14.0 Other 89''

	This process is included in the system described in Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	The manufacturing process is a gate-to-gate process and does not include the resources needed. Theese are specified in 'Function'.
Time Boundary	Data originally presented in an environmental product declaration from Volvo AB for the year 2001.
Geographical Boundary	The chassi is manufactured by Volvo AB, in Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': ''A diesel truck and a gas truck have some construction differences, primarily concerning the engine. The data used in this study represent manufacturing of a diesel truck. Data representing a gas truck were not available, but the differences were assumed to be small in relation to a complete vehicle.''
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2001
Data Type	Monitored data, continuous
Represents	See 'Function'.
Method	Not applicable.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden at http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	See 'Nature Boundaries', 'Function' and 'Functional Unit'.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Resource	Water	31740			kg	Water	Sweden
	Output	Emission	BOD	0.43			kg	Water	Sweden
	Output	Emission	CFC	0.35			kg	Air	Sweden
	Output	Emission	CO	1.09			kg	Air	Sweden
	Output	Emission	CO2	1400			kg	Air	
	Output	Emission	COD	3.4			kg	Water	Sweden
	Output	Emission	HCFC-22	0.0000475			kg	Air	Sweden
	Output	Emission	NOx	2.84			kg	Air	Sweden
	Output	Emission	Particles	0.56			kg	Air	Sweden
	Output	Emission	SO2	2.06			kg	Air	Sweden
	Output	Emission	VOC	5.46			kg	Air	Sweden
	Output	Product	Chassi	5275			kg	Technosphere	Sweden

	Output	Residue	Hazardous waste - landfill	7.03			kg	Technosphere	Sweden
	Output	Residue	Hazardous waste - treated	96.7			kg	Technosphere	Sweden
	Output	Residue	Landfill waste	265			kg	Technosphere	Sweden
	Output	Residue	Treated waste	305			kg	Technosphere	Sweden

About Inventory	
Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Master Thesis Report
Detailed Purpose	This process data set is a part of the LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Not applicable - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	Excerpts from the report (for report see link in 'Publication'): ''Data concerning production of aluminium, copper and steel were found in an LCA study by Sunér (1996). Steel is the material making up the main part of the vehicle. Data for the steel production represents primary steel production at SSAB tunnplåt in Luleå, Sweden, with an economic allocation among materials produced there, and also production of secondary steel at Fundia steel in Smedjebacken, Sweden. Primary and secondary steel were presented separately in the report. To get usable data for the waste collection vehicle, the proportions used was assumed to be 60% primary and 40% secondary steel, which is the world average (SSAB, 2004).'' NB: References in the above text can be found in the report, in 'Literature Reference'. ''Copper was produced at Rönnskär smelter, Boliden mineral AB in Skelleftehamn, Sweden. 25-30% was secondary material. An economic allocation among several materials was used. The amount of copper raw material used in Sunér's economic allocation did not agree with the amount of metal produced. (Less raw copper was used than copper metal produced.) Therefore, the unallocated value for copper resource consumption was used instead.'' ''Data used concerning production of paper, wood and glass are average data of these material groups (Rydh and Sun, 2003). The wood used was assumed to be of the "low impact" group.'' NB: References in the above text can be found in the report, in 'Literature Reference'. ''Brake pads production was calculated as steel, electronics as copper and bitumen as oil. Environmental impact from the material production was then calculated using general material inventory data (section 3.1.1). The amount of lead batteries, as in Table 3, was originally given as content of lead in the truck, but was recalculated as lead batteries. This was done by using the same material composition as in the batteries used in the loading of the hybrid vehicle, but without steel through, and at the same time decreasing the amount of plastics and removing sulphuric acid from the list. The same battery production data were used as for the production of hybrid equipment batteries (see section 3.2.3)'' NB: Table 3 in the above text is the same table as table 3 in 'Function'. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Truck Göteborg to SAKAB

Administrative	
Finished	Y
Date Completed	1999-04-20
Copyright	
Availability	public

Technical System	
Name	Truck Göteborg to SAKAB
Functional Unit	36 m3 oil-sludge transported from Göteborg to Sakab
Functional Unit Explanation	The loading capacity of the truck is 40 ton. All transports are carried out full loaded to Sakab and empty on return.
Process Type	Gate to gate
Site	
Sector	Land transport
Owner	
Technical system description	Transporting oil-sludge from Göteborg to SAKAB, 250 km. Totally was 36 m3 oil-sludge transorted from Göteborg to Kumla during 1997. The density of oil sludge is one ton / m3. The vehicle arrives to Kumla full loaded but is empty on the return. Transporting oil-sludge from the source to the destination by truck of type Euro class 1 consuming fuel class MK1. The weight of the vehicle is 60 ton full loaded (40 ton oil-sludge). The transports are all carried out on main roads. Reci's own transportation division carries out the transportation with four vehicles. All transports are carried out full loaded or empty. The transportation step consumes diesel and releases emissions to the system environment.

System Boundaries	
Nature Boundary	Only emissions legeslated by law is represented by NTM.
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary is set to Sweden.
Other Boundaries	The loading and unloading steps are neglected in terms of resource use and emissions. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. It is assumed that there occurs no spill.
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1998-12-29
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The truck's engine is of type Euro class 1 and it consumes diesel MK1. NTM presents data about the emissions. NOx, HC, PM, CO, CO2 are presented in grams released per litre fuel consumed. SO2 is presented in part per million (ppm). The fuel consumption is 0,5 litre/km for the truck when full-loaded (Tomas Larsson) and 0,31 litre/km when empty (NTM). The density for diesel is 0,81 kg / litre and 9,77 kWh / litre. (NTM) Transporting oil-sludge from

	Göteborg to SAKAB, 250 km. Totally was 36 m3 oil-sludge transorted from Göteborg to Kumla during 1997. The density of oil sludge is one ton / m3. The vehicle arrives to Kumla full loaded (40 tonnes of cargo) and is empty on the return.
Literature Reference	http://www.ntm.a.se/emissioner/car/inledning/htm, latest uppdated 1998-09-08 Tomas Larsson truck driver Reci Transport AB
Notes	See 'Nature Boundaries', 'Function' and 'Functional Unit'.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Oil-sludge	36			m3	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm Tomas Larsson, Chauffeur, Reci Transport AB	Input	Refined resource	Diesel environmental class 1	148			kg	Technosphere	Sweden
	Output	Cargo	Oil-sludge	36			m3	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	CO	0.62			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	CO2	474			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	HC	0.33			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	NOx	4.9			kg	Air	Sweden
	Output	Emission	Particles	0.09			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	SO2	0.06			kg	Air	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology --- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000 certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emission released from the vehicle during transportation.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are specific for transportation by truck. Data are valid for average truck-transportation in Sweden. The calculations are conducted with the trucks employed by Reci Transport AB. The transports that are carried out by entrepreneurs are assumed to employ trucks with the same characteristics.

About Data	NTM has in association with VOLVO Trucks and Scania conducted simulations and calculations during 1997 to established the fuel consumption for trucks, both when full loaded and empty. The simulations are based on certification values of engines and the fuel consumption during operation under Swedish conditions. The emissions that are released from the truck are coupled to the fuel consumption, which is known for full loaded trucks employed by Reci. The data concerning fuel consumption for empty trucks that are presented by NTM is used. When the fuel consumption is known for a particular vehicle, its specific release of emissions can be calculated. The relevance of the gathered data was verified with Tage Hilmersson, Manager at Reci Transport AB in Stenungsund. Specific fuel consumption for the vehicles conducted for transportation was recieved from Tomas Larsson, truck driver at Reci Transport AB in Stenungsund. If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Truck Halmstad to Göteborg (Scrap)

Administrative	
Finished	Y
Date Completed	1999-04-20
Copyright	
Availability	public

Technical System	
Name	Truck Halmstad to Göteborg (Scrap)
Functional Unit	10 ton of scrap transported from Halmstad to Göteborg
Functional Unit Explanation	The loading capacity of the truck is 40 ton. All transports are carried out full loaded.
Process Type	Gate to gate
Site	
Sector	Land transport
Owner	
Technical system description	Transporing scrap from Halmstad to Göteborg, 135 km. Totally was 10 tonnes of scrap transported from Halmstad to Göteborg. The density of scrap is one ton / m3. The truck returns to Halmstad with an alternative cargo. Transporting scrap from the source to the destination by truck of type Euro class 1 consuming fuel class MK1. The weight of the vehicle is 60 ton full loaded (40 ton scrap). The transports are all carried out on main roads. Reci's own transportation division carries out the transportation with four vehicles. All transports are carried out full loaded. The transportation step consumes diesel and releases emissions to the system environment.

System Boundaries	
Nature Boundary	Only emissions legeslated by law is represented by NTM.
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary is set to Sweden.

Other Boundaries	The loading and unloading steps are neglected in terms of resource use and emissions. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. It is assumed that there occurs no spill.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998-12-29
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The truck's engine is of type Euro class 1 and it consumes diesel MK1. NTM presents data about the emissions. NOx, HC, PM, CO, CO2 are presented in grams released per litre fuel consumed. SO2 is presented in part per million (ppm). The fuel consumption is 0,5 litre/km for the truck when full-loaded (Tomas Larsson). The density for diesel is 0,81 kg / litre and 9,77 kWh / litre. (NTM) Transporing scrap from Halmstad to Göteborg, 135 km. Totally was 10 tonnes of scrap transported from Halmstad to Göteborg. The density of scrap is one ton / m3. The truck is fully loaded (40 tonnes of cargo) when carrying out the transportation and returns to Halmstad with an alternative cargo.
Literature Reference	http://www.ntm.a.se/emissioner/car/inledning/htm, latest uppdated 1998-09-08 Tomas Larsson truck driver Reci Transport AB
Notes	See 'Nature Boundaries', 'Function' and 'Functional Unit'.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Scrap	10			tonne	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm Tomas Larsson, Chauffeur, Reci Transport AB	Input	Refined resource	Diesel environmental class 1	13.7			kg	Technosphere	Sweden
	Output	Cargo	Scrap	10			tonne	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	CO	0.06			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	CO2	43.9			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	HC	0.03			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	NOx	0.46			kg	Air	Sweden
	Output	Emission	Particles	0.01			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	SO2	0.01			kg	Air	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology -- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --

Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000 certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emission released from the vehicle during transportation.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are specific for transportation by truck. Data are valid for average truck-transportation in Sweden. The calculations are conducted with the trucks employed by Reci Transport AB. The transports that are carried out by entrepreneurs are assumed to employ trucks with the same characteristics.
About Data	NTM has in association with VOLVO Trucks and Scania conducted simulations and calculations during 1997 to established the fuel consumption for trucks, both when full loaded and empty. The simulations are based on certification values of engines and the fuel consumption during operation under Swedish conditions. The emissions that are released from the truck are coupled to the fuel consumption, which is known for full loaded trucks employed by Reci. The data concerning fuel consumption for empty trucks that are presented by NTM is used. When the fuel consumption is known for a particular vehicle, its specific release of emissions can be calculated. The relevance of the gathered data was verified with Tage Hilmersson, Manager at Reci Transport AB in Stenungsund. Specific fuel consumption for the vehicles conducted for transportation was recieved from Tomas Larsson, truck driver at Reci Transport AB in Stenungsund. If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Truck Halmstad to Göteborg (Water-sludge)

Administrative	
Finished	Y
Date Completed	1999-04-20
Copyright	
Availability	public

Technical System	
Name	Truck Halmstad to Göteborg (Water-sludge)
Functional Unit	501m3 of water sludge transported from Halmstad to Göteborg
Functional Unit Explanation	The loading capacity of the truck is 40 ton. All transports are carried out full loaded.
Process Type	Gate to gate
Site	
Sector	Land transport
Owner	

Technical system description	The transportation of water-sludge from Halmstad to Göteborg, 135 km. Totally was 501 m3 transported from Halmstad to Göteborg during 1997. The density of water sludge is one ton / m3. Reci Transport AB carries out the transportation. The truck returns to Halmstad with an alternative cargo. Transporting water-sludge from the source to the destination by truck of type Euro class 1 consuming fuel class MK1. The weight of the vehicle is 60 ton full loaded (40 ton water sludge). The transports are all carried out on main roads. Reci's own transportation division carries out the transportation with four vehicles. All transports are carried out full loaded. The transportation step consumes diesel and releases emissions to the system environment.

System Boundaries

Nature Boundary	Only emissions legeslated by law is represented by NTM.
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary is set to Sweden.
Other Boundaries	The loading and unloading steps are neglected in terms of resource use and emissions. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. It is assumed that there occurs no spill.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998-12-29
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The truck's engine is of type Euro class 1 and it consumes diesel MK1. NTM presents data about the emissions. NOx, HC, PM, CO, CO2 are presented in grams released per litre fuel consumed. SO2 is presented in part per million (ppm). The fuel consumption is 0,5 litre/km for the truck when full-loaded (Tomas Larsson) . The density for diesel is 0,81 kg / litre and 9,77 kWh / litre. (NTM) The transportation of water-sludge from Halmstad to Göteborg, 135 km. Totally was 501 m3 transported from Halmstad to Göteborg during 1997. The density of water sludge is one ton / m3. Reci Transport AB carries out the transportation, full loaded (40 ton cargo). The truck returns to Halmstad with an alternative cargo.
Literature Reference	http://www.ntm.a.se/emissioner/car/inledning/htm, latest uppdated 1998-09-08 Tomas Larsson truck driver Reci Transport AB
Notes	See 'Nature Boundaries', 'Function' and 'Functional Unit'.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Water-sludge	501			m3	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm Tomas Larsson, Chauffeur, Reci Transport AB	Input	Refined resource	Diesel environmental class 1	685			kg	Technosphere	Sweden
	Output	Cargo	Water-sludge	501			m3	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm	Output	Emission	CO	2.9			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm	Output	Emission	CO2	2198			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm	Output	Emission	HC	1.5			kg	Air	Sweden

Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm	Output	Emission	NOx	22.8			kg	Air	Sweden
	Output	Emission	Particles	0.42			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm	Output	Emission	SO2	0.27			kg	Air	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology --- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000 certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emission released from the vehicle during transportation.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are specific for transportation by truck. Data are valid for average truck-transportation in Sweden. The calculations are conducted with the trucks employed by Reci Transport AB. The transports that are carried out by entrepreneurs are assumed to employ trucks with the same characteristics.
About Data	NTM has in association with VOLVO Trucks and Scania conducted simulations and calculations during 1997 to established the fuel consumption for trucks, both when full loaded and empty. The simulations are based on certification values of engines and the fuel consumption during operation under Swedish conditions. The emissions that are released from the truck are coupled to the fuel consumption, which is known for full loaded trucks employed by Reci. The data concerning fuel consumption for empty trucks that are presented by NTM is used. When the fuel consumption is known for a particular vehicle, its specific release of emissions can be calculated. The relevance of the gathered data was verified with Tage Hilmersson, Manager at Reci Transport AB in Stenungsund. Specific fuel consumption for the vehicles conducted for transportation was recieved from Tomas Larsson, truck driver at Reci Transport AB in Stenungsund. If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Truck Halmstad to SAKAB

Administrative

Finished	Y

Date Completed	1999-04-20
Copyright	
Availability	public

Technical System

Name	Truck Halmstad to SAKAB
Functional Unit	241 m3 oil-sludge transported from Halmstad to Sakab.
Functional Unit Explanation	The loading capacity of the truck is 40 ton. All transports are carried out full loaded to Sakab and empty on the return.
Process Type	Gate to gate
Site	
Sector	Land transport
Owner	
Technical system description	Transporting oil-sludge from Halmstad to SAKAB, 385 km. The total amount of oil sludge from Halmstad to Kumla during 1997 was 241 m3. The density of oil sludge is one ton / m3. The vehicle arrives to Kumla full loaded but is empty on the return. Transporting oil-sludge from the source to the destination by truck of type Euro class 1 consuming fuel class MK1. The weight of the vehicle is 60 ton full loaded (40 ton oil-sludge). The transports are all carried out on main roads. Reci's own transportation division carries out the transportation with four vehicles. All transports are carried out full loaded or empty. The transportation step consumes diesel and releases emissions to the system environment.

System Boundaries

Nature Boundary	Only emissions legeslated by law is represented by NTM.
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary is set to Sweden.
Other Boundaries	The loading and unloading steps are neglected in terms of resource use and emissions. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. It is assumed that there occurs no spill.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998-12-29
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The truck's engine is of type Euro class 1 and it consumes diesel MK1. NTM presents data about the emissions. NOx, HC, PM, CO, CO2 are presented in grams released per litre fuel consumed. SO2 is presented in part per million (ppm). The fuel consumption is 0,5 litre/km for the truck when full-loaded (Tomas Larsson) and 0,31 litre/km when empty (NTM). The density for diesel is 0,81 kg / litre and 9,77 kWh / litre. (NTM) Transporting oil-sludge from Halmstad to SAKAB, 385 km. The total amount of oil sludge from Halmstad to Kumla during 1997 was 241 m3. The density of oil sludge is one ton / m3. The vehicle arrives to Kumla full loaded (40 tonnes of cargo) but is empty on the return.
Literature Reference	http://www.ntm.a.se/emissioner/car/inledning/htm, latest uppdated 1998-09-08 Tomas Larsson truck driver Reci Transport AB
Notes	See 'Nature Boundaries', 'Function' and 'Functional Unit'.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Oil-sludge	241			m3	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm Tomas Larsson, Chauffeur, Reci Transport AB	Input	Refined resource	Diesel environmental class 1	1522			kg	Technosphere	Sweden
	Output	Cargo	Oil-sludge	241			m3	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	CO	6.38			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	CO2	4885			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	HC	3.39			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	NOx	50.7			kg	Air	Sweden
	Output	Emission	Particles	0.951			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	SO2	0.6			kg	Air	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology -- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000 certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emission released from the vehicle during transportation.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are specific for transportation by truck. Data are valid for average truck-transportation in Sweden. The calculations are conducted with the trucks employed by Reci Transport AB. The transports that are carried out by entrepreneurs are assumed to employ trucks with the same characteristics.
About Data	NTM has in association with VOLVO Trucks and Scania conducted simulations and calculations during 1997 to established the fuel consumption for trucks, both when full loaded and empty. The simulations are based on certification values of engines and the fuel consumption during operation under Swedish conditions. The emissions that are released from the truck are coupled to the fuel consumption, which is known for full loaded trucks employed by Reci. The data concerning fuel consumption for empty trucks that are presented by NTM is used. When the fuel consumption is known for a particular vehicle, its specific release of emissions can be calculated. The relevance of the gathered data was verified with Tage Hilmersson, Manager at Reci Transport AB in Stenungsund. Specific fuel consumption for the vehicles conducted for transportation was recieved from Tomas Larsson, truck driver at Reci Transport AB in Stenungsund.

	If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Truck Jönköping to Halmstad

Administrative	
Finished	Y
Date Completed	1999-04-20
Copyright	
Availability	public

Technical System	
Name	Truck Jönköping to Halmstad
Functional Unit	5389 m3 of waste oil transported from Jönköping to Halmstad
Functional Unit Explanation	The loading capacity of the truck is 40 ton. All transports are carried out full loaded.
Process Type	Gate to gate
Site	
Sector	Land transport
Owner	
Technical system description	Transporting waste oil from Jönköping to Halmstad, 165 km. The density for the waste oil is 0,93 ton / m3 due to the water pollution. The total amount of waste oil transported from Halmstad from Jönköping during 1997 was 5389 m3. Transporting waste oil from the source to the destination by truck of type Euro class 1 consuming fuel class MK1. The weight of the vehicle is 60 ton full loaded (40 ton waste oil). The transports are all carried out on main roads. Reci's own transportation division carries out the transportation with four vehicles. Entrepreneurs also carry out some transportation. The entrepreneurs' trucks have the same characteristics as the trucks used by Reci. All transports are carried out full loaded. The transportation step consumes diesel and releases emissions to the system environment.

System Boundaries	
Nature Boundary	Only emissions legeslated by law is represented by NTM.
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary is set to Sweden.
Other Boundaries	The loading and unloading steps are neglected in terms of resource use and emissions. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. It is assumed that there occurs no spill.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998-12-29
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The truck's engine is of type Euro class 1 and it consumes diesel MK1. NTM presents data about the emissions. NOx, HC, PM, CO, CO2 are presented in grams released per litre fuel consumed. SO2 is presented in part per million (ppm). The fuel consumption is 0,5 litre/km for the truck when full-loaded (Tomas Larsson) . The density for diesel is 0,81 kg / litre and 9,77 kWh / litre. (NTM) Transporting waste oil from Jönköping to Halmstad, 165 km. The density for the waste oil is 0,93 ton / m3 due to the water pollution. The total amount of waste oil transported from Halmstad from Jönköping during 1997 was 5389 m3. The truck arrives to Halmstad fully loaded (40 tonnes of cargo) but returns to Jönköping with an alternative cargo.
Literature Reference	http://www.ntm.a.se/emissioner/car/inledning/htm, latest uppdated 1998-09-08 Tomas Larsson truck driver Reci Transport AB
Notes	See 'Nature Boundaries', 'Function' and 'Functional Unit'.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Waste oil	5389			m3	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm Tomas Larsson, Chauffeur, Reci Transport AB	Input	Refined resource	Diesel environmental class 1	8373			kg	Technosphere	Sweden
	Output	Cargo	Waste oil	5389			m3	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm	Output	Emission	CO	35.1			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm	Output	Emission	CO2	26876			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm	Output	Emission	HC	18.6			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm	Output	Emission	NOx	279			kg	Air	Sweden
	Output	Emission	Particles	5.17			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se/emissioner/car/inledning/htm	Output	Emission	SO2	3.31			kg	Air	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical Environmental Planning, Chalmers University of Technology
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000 certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emission released from the vehicle during transportation.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden

Applicability	The data are specific for transportation by truck. Data are valid for average truck-transportation in Sweden. The calculations are conducted with the trucks employed by Reci Transport AB. The transports that are carried out by entrepreneurs are assumed to employ trucks with the same characteristics.
About Data	NTM has in association with VOLVO Trucks and Scania conducted simulations and calculations during 1997 to established the fuel consumption for trucks, both when full loaded and empty. The simulations are based on certification values of engines and the fuel consumption during operation under Swedish conditions. The emissions that are released from the truck are coupled to the fuel consumption, which is known for full loaded trucks employed by Reci. The data concerning fuel consumption for empty trucks that are presented by NTM is used. When the fuel consumption is known for a particular vehicle, its specific release of emissions can be calculated. The relevance of the gathered data was verified with Tage Hilmersson, Manager at Reci Transport AB in Stenungsund. Specific fuel consumption for the vehicles conducted for transportation was recieved from Tomas Larsson, truck driver at Reci Transport AB in Stenungsund. If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Truck Reci Göteborg to Sävenäs

Administrative	
Finished	Y
Date Completed	1999-04-20
Copyright	
Availability	public

Technical System	
Name	Truck Reci Göteborg to Sävenäs
Functional Unit	160 tonnes of scrap transported from Reci Göteborg to Sävenäs
Functional Unit Explanation	The loading capacity of the truck is 40 ton. All transports are carried out full loaded to Sävenäs and empty on return.
Process Type	Gate to gate
Site	
Sector	Land transport
Owner	
Technical system description	The transportation of scrap from Reci in Göteborg to Sävenäs, 10 km. The amount of scrap from Reci Göteborg to Sävenäs in 1997 was 160 tonnes. The density of scrap is one ton / m3. The vehicle arrives to Sävenäs full loaded but is empty on the return. Transporting goods from the source to the destination by truck of type Euro class 1 consuming fuel class MK1. The weight of the vehicle is 60 ton full loaded (40 ton scrap). The transports are all carried out on main roads. Reci's own transportation division carries out the transportation with four vehicles. All transports are carried out full loaded or empty. The transportation step consumes diesel and releases emissions to the system environment.

System Boundaries	
Nature Boundary	Only emissions legeslated by law is represented by NTM.

Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary is set to Sweden.
Other Boundaries	The loading and unloading steps are neglected in terms of resource use and emissions. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. It is assumed that there occurs no spill.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998-12-29
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The truck's engine is of type Euro class 1 and it consumes diesel MK1. NTM presents data about the emissions. NOx, HC, PM, CO, CO2 are presented in grams released per litre fuel consumed. SO2 is presented in part per million (ppm). The fuel consumption is 0,5 litre/km for the truck when full-loaded (Tomas Larsson) and 0,31 litre/km when empty (NTM). The density for diesel is 0,81 kg / litre and 9,77 kWh / litre. (NTM) The transportation of scrap from Reci in Göteborg to Sävenäs, 10 km. The amount of scrap from Reci Göteborg to Sävenäs in 1997 was 160 tonnes. The density of scrap is one ton / m3. The vehicle arrives to Sävenäs full loaded (40 tonnes of cargo), but is empty on the return.
Literature Reference	http://www.ntm.a.se/emissioner/car/inledning/htm, latest uppdated 1998-09-08 Tomas Larsson truck driver Reci Transport AB
Notes	See 'Nature Boundaries', 'Function' and 'Functional Unit'.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Scrap	160			tonne	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm Tomas Larsson, Chauffeur, Reci Transport AB	Input	Refined resource	Diesel environmental class 1	26.2			kg	Technosphere	Sweden
	Output	Cargo	Scrap	160			tonne	Technosphere	
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	CO	0.11			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	CO2	84.2			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	HC	0.06			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	NOx	0.87			kg	Air	Sweden
	Output	Emission	Particles	0.02			kg	Air	Sweden
Date concieved: 1998-12-29 Data type: Calculated Literature: http://www.ntm.a.se /emissioner/car/inledning/htm	Output	Emission	SO2	0.01			kg	Air	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology --

	Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result will be used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000 certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emission released from the vehicle during transportation.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are specific for transportation by truck. Data are valid for average truck-transportation in Sweden. The calculations are conducted with the trucks employed by Reci Transport AB. The transports that are carried out by entrepreneurs are assumed to employ trucks with the same characteristics.
About Data	NTM has in association with VOLVO Trucks and Scania conducted simulations and calculations during 1997 to established the fuel consumption for trucks, both when full loaded and empty. The simulations are based on certification values of engines and the fuel consumption during operation under Swedish conditions. The emissions that are released from the truck are coupled to the fuel consumption, which is known for full loaded trucks employed by Reci. The data concerning fuel consumption for empty trucks that are presented by NTM is used. When the fuel consumption is known for a particular vehicle, its specific release of emissions can be calculated. The relevance of the gathered data was verified with Tage Hilmersson, Manager at Reci Transport AB in Stenungsund. Specific fuel consumption for the vehicles conducted for transportation was recieved from Tomas Larsson, truck driver at Reci Transport AB in Stenungsund. If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Truck tire production. ESA-DBP

Administrative	
Finished	Y
Date Completed	Unknown
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Truck tire production. ESA-DBP
Functional Unit	One rubber tire á 5.47 kg.
Functional Unit Explanation	Not applicable.
Process Type	Gate to gate

Site	Unknown
Sector	Materials and components
Owner	Unknown
Technical system description	Manufacturing of truck tires. This process is included in the system described in ''Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	Unknown. The documentor of data makes a qualified guess that the average year of data is year 1998, based on the publication years of the literature references that are referred to in the report.
Geographical Boundary	The tires are manufactured on behalf of the company Continental AG, but where the factory is located is not specified.
Other Boundaries	For other boundaries and assumptions see 'About Data' below.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	Unknown.
Data Type	Derived, mixed
Represents	See 'Function'.
Method	For method see 'About data' .
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Resource	Crude oil	6.01			kg	Ground	
	Input	Resource	Hard coal	2.16			kg	Ground	
	Input	Resource	Iron in ore	1.17			kg	Ground	
	Input	Resource	Latex rubber	2.57			kg	Ground	
	Input	Resource	Lignite	3.46			kg	Ground	
	Input	Resource	Natural gas	5.41			kg	Ground	
	Input	Resource	Sulphur	0.20			kg	Ground	
	Output	Emission	BOD	0.00778			kg	Water	
	Output	Emission	Ca2+	0.0000175			kg	Water	
	Output	Emission	Cl-	1.10			kg	Water	

	Output	Emission	CO	0.006			kg	Air	
Notes: Value reliability questioned. Value as reported in reference.	Output	Emission	CO_2	21.1			kg	Air	
	Output	Emission	COD	0.0194			kg	Water	
	Output	Emission	Methane	0.0147			kg	Air	
	Output	Emission	N_2O	0.00262			kg	Air	
	Output	Emission	Na^+	0.282			kg	Water	
	Output	Emission	NO_x	0.011			kg	Air	
	Output	Emission	SO_2	0.0115			kg	Air	
	Output	Emission	SO_4^{2-}	0.467			kg	Water	
	Output	Product	Rubber tire	5.47			kg	Technosphere	
	Output	Residue	Hazardous waste	0.0525			kg	Technosphere	
	Output	Residue	Household waste	0.763			kg	Technosphere	
	Output	Residue	Inert residues	13.5			kg	Technosphere	
	Output	Residue	NMVOC	0.0161			kg	Technosphere	
	Output	Residue	Ore dressing residue	2.08			kg	Technosphere	
	Output	Residue	Rubber	0.181			kg	Technosphere	
	Output	Residue	Slags and ashes	0.0448			kg	Technosphere	
	Output	Residue	Sludge	0.0773			kg	Technosphere	
	Output	Residue	Unspecified waste	1.27			kg	Technosphere	

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	LCA practitioners.
General Purpose	Master Thesis Report.
Detailed Purpose	This process data set is a part of the comparative LCA for 'Gas-Electric Hybrid Waste Collection Vehicle'.
Commissioner	Not applicable - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpt from the report (for report see link in 'Publication'): ''The rubber used is mainly for tires (which are often replaced). Car tires manufactured at Continental AG have been studied in an LCA (Krömer et al., 1999). In the presentation of the inventory, results for production and use are summed up, but there are also figures on the amounts of total resource use, air and water emissions and waste respectively in different phases of the life cycle. Using these figures, the environmental impacts from the production phase, which is the relevant part for this study, was calculated. Regarding resources, all were assigned to the production phase except petroleum. Petroleum was instead estimated by the ratios of total resource use in the raw material acquisition, production and transport, respectively, and the fraction that petroleum makes up of the total resources in each of these processes. Furthermore, petroleum was assumed to be equivalent to crude oil since natural gas was presented separately. The production phase accounts for 4.6% of the emissions to air, except for CO_2 and CO, which make up 98% and 1.2%, respectively, of the emissions during use. The rest of the total CO_2 and CO emissions were assigned to the production phase. 97.2% of the emissions to water was assigned to the production phase. The waste generated comes to 95.4% from the production phase, but for inert residues, the share from production is 23.7%. To clarify what values have been used, the inputs and outputs for production of one tire of 5.47 kg are presented below in Table 2. When using these data in this LCA to represent truck tires, the values were scaled up according to weight.'' NB: The ''Table 2'' from the above text, is represented by the 'Flow Table' above. ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis.

	Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Truck with semitrailer, max 42 tonnes, future

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Truck with semitrailer, max 42 tonnes, future
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven truck with semitrailer, with engine representing best available technology (proposed Euro 3 environmental standard) with oxidation filter and catalytic control. The equipage is used for international long-distance traffic. Maximum gross weight: 42 tonnes. Kerb weight: 17 tonnes. Available loading capacity with regard to weight: 25 tonnes. Length: 18,5 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents best available technology, not yet in regular use.
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel

	-Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The emissions were calculated using emission factors obtained by a new test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level. See specific QMetaData for each flow.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	0.77			MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.0087			g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel	Output	Emission	CO2	56			g	Air	

See QMetaData for the Diesel flow for further information									
Method: See QMetaData for NOx	Output	Emission	HC	0.0087			g	Air	
Date concieved: 1996-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors (g/kWh) obtained by a a new test cycle, on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The tests was perfomed by Motortestcenter. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)] *emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) **The following data was used in the calculations:** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1:* Thermal value: 43,43 MJ/kg Density: 0,81 kg/l Sulphur content: 10 ppm The data were supplied by the Swedish Petroleum Institute *The emission factors were:* -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data can be found in Ahlvik. Literature: Ahlvik P., Almén J., Grägg K., Laveskog A. *Avgasemissioner med alternativa bränslen* Motortestcenter, februari 1996 (Published in SOU 1996:184 *Bilagor till betänkande av alternativbränsleutredningen*)	Output	Emission	NOx	0.44			g	Air	
Method: See QMetaData for NOx	Output	Emission	Particles	0.0017			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00034			g	Air	

About Inventory

Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The

	work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The ambition with the data was to get a picture of future energy use and emissions. The data represents best available technology, not yet in use.
About Data	The data is based on tests on the engine performed in a laboratory according to a new test cycle (proposed for standardisation). This means that several parameters that influence the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Truck with semitrailer, max 42 tonnes, manufactured after 1996 [Euro 2]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Truck with semitrailer, max 42 tonnes, manufactured after 1996 [Euro 2]

Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven truck with semitrailer, with engine manufactured after 1996 (Euro 2 environmental standard). The equipage is used for international long-distance traffic. Maximum gross weight: 42 tonnes. Kerb weight: 17 tonnes. Available loading capacity with regard to weight: 25 tonnes. Length: 18,5 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured after 1996
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation, the *maximum value* refer to an engine run 500 000 km. No minimum value was given.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine	Input	Refined resource	Diesel environmental class 1	0.8	0.79	0.82	MJ	Technosphere	
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.064		0.078	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	59	58	60	g	Air	
Method: See QMetaData for NOx.	Output	Emission	HC	0.037		0.039	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refers to an engine run	Output	Emission	NOx	0.58		0.59	g	Air	

500 000 km. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)] *emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine*: -NOx 6,3 g/kWh -HC 0,4 g/kWh -CO 0,7 g/kWh -Particles 0,11 g/kWh -Degree of efficiency on the engine: 41 % (assumption). The data was supplied by Volvo Truck Corporation. *Maximum value i.e. engine run 500 000 km* The data was supplied by Volvo Truck Corporation and expressed as percentage degeneration in emissions in relation to the average engine. The degeneration factors are based on special degeneration factor tests for EPA/CARB on 12 litre engines. The tests were performed on four engines run 470 000 km. The degeneration factors are an average of the tests. -NOx 6,4 g/kWh - 1,5 % degeneration in relation to the average engine -HC 0,42 g/kWh - 4 % degeneration in relation to the average engine -CO 0,8 g/kWh - 20 % degeneration in relation to the average engine -Particles 0,11 g/kWh - 2 % degeneration in relation to the average engine -Degree of efficiency on the engine: 41 % (assumption) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx.	Output	Emission	Particles	0.0101		0.0104	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the	Output	Emission	SO2	0.00037	0.00035	0.00038	g	Air	

sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information									

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the

terminal for further transport.
--*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited
--*Parcel goods (<100 kg)* are normally handled in small vehicles

The following vehicles and equipages are used for transportation in Sweden:
--*Truck max 3,5 tonnes* is mainly used for transportation of parcels.
--*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic.
--*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic.
--*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods.
--*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland.
--*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic.

Utilisation level
The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low.

The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden):
-excavated materials and round timber - 50%
-manufactured products (wholesale goods) - slightly more than 20%
-provisions and animal forage - approx. 15%
-mixed cargo (general goods) approx - 10 %.

The Swedish fleet
The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories:
After 1996: 10 %
95-92: 33%
Before 1992 52 %
The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes.

Bulky goods
The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business.

Fuel
The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions.

Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions.

International road transports
The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.

About Data

Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc.

Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years.

The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions.

A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the

	maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Truck with semitrailer, max 42 tonnes, manufactured before 1992 [Euro 0]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Truck with semitrailer, max 42 tonnes, manufactured before 1992 [Euro 0]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven truck with semitrailer, with engine manufactured before 1992 (Euro 0 environmental standard). The equipage is used for international long-distance traffic. Maximum gross weight: 42 tonnes. Kerb weight: 17 tonnes. Available loading capacity with regard to weight: 25 tonnes. Length: 18,5 metres.

System Boundaries	
Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2.

	Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured before 1992
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, the *maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to voluntary European emission regulations for diesel engines before 1992.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur	Input	Refined resource	Diesel environmental class 1	0.8	0.8	0.81	MJ	Technosphere	

content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx.	Output	Emission	CO	0.13		1.06	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	59	58	59	g	Air	
Method: See QMetaData for NOx.	Output	Emission	HC	0.13		0.22	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to voluntary European emission regulations for diesel engines before 1992. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/ (loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:*: -NOx 11 g/kWh -HC 1,5 g/kWh -CO 1,5 g/kWh -Particles 0,4 g/kWh (estimated) -Degree of efficiency on the engine:39 % (assumed) The data was supplied by the Volvo Truck Corporation. *Maximum value, i.e. voluntary European emission regulations:* -NOx 14 g/kWh -HC 2,5 g/kWh -CO 12 g/kWh -Particles - g/kWh (not given) -Degree of efficiency on the engine: 39 %. No minimum value was given. *The ECE R49 is a steady state cycle for*	Output	Emission	NOx	1	0.78	1.2	g	Air	

heavy duty truck engines. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx.	Output	Emission	Particles	0.035			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00037	0.00036	0.00038	g	Air	

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business. The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.

Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport.* The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 % 95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions.

	International road transports The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Truck with semitrailer, max 42 tonnes, manufactured between 1992 and 1995 [Euro1]

Administrative	
Finished	Y
Date Completed	1997-11-19
Copyright	NGM (Nätverket för Godstransporter och Miljön)
Availability	This version is only available to the members of NTM. The data is continously updated, and the data user should always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se.

Technical System	
Name	Truck with semitrailer, max 42 tonnes, manufactured between 1992 and 1995 [Euro1]
Functional Unit	1 tonkm, 70 %
Functional Unit Explanation	Energy use and emissions refer to the transportation of 1 ton goods 1 kilometre for an utilisation level of 70 %. An utilisation level of 70 % is representative for Swedish domestic traffic if *empty trips are not included.*
Process Type	Unit operation
Site	Sweden

Sector	Land transport
Owner	Sweden
Technical system description	Operation of a diesel driven truck with semitrailer, with engine manufactured between 1992 and 1995 (Euro 1 environmental standard). The equipage is used for international long-distance traffic. Maximum gross weight: 42 tonnes. Kerb weight: 17 tonnes. Available loading capacity with regard to weight: 25 tonnes. Length: 18,5 metres.

System Boundaries

Nature Boundary	Regulated emissions to air are included. The parameters that are presented are: -regulated emissions for diesel engines: NOx, HC, particles and CO -fuel regulated: SO2 -tax regulated CO2. Diffuse emissions to air, emissions to water and ground, noise, encroachment and other environmental loads have not been considered.
Time Boundary	The data represents trucks with engine manufactured between 1992 and 1995
Geographical Boundary	The data is based on Swedish conditions.
Other Boundaries	The average utilisation level is 70 % which is representative for Swedish domestic traffic if *empty trips are not included.* *Parameters not considered* -Driving technique -External conditions i.e. road conditions, climate etc. -Maintenance level of the vehicle *Excluded subsystems* -Exhaust emission control -Precombustion, i.e. production and distribution of the fuel -Maintenance of the vehicle -Erection and operation of infrastructure -After-treatment of the vehicle -Handling of production rests
Allocations	N/A
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1997-01-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	The emissions were calculated using emission factors obtained by the ECE R49 test cycle, together with assumptions on the efficiency of the engine, fuel consumption, type of fuel used and utilisation level (see specific QMetaData for a description on methods used for each flow). The *quantity value for the energy use* refer to average fuel consumption, *the maximum and minimum value* refer to changes in the efficiency of the engine due to degeneration. The emissions of CO2 and SO2 is based on the fuel consumption. For *emissions of NOx, HC, particles and CO, the quantity value* refer to an average engine guaranteed by Volvo Truck Corporation and the *maximum value* refer to the emission regulations for diesel engines according to the emission standard Euro I.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The diesel consumption	Input	Refined resource	Diesel environmental class 1	0.8	0.8	0.81	MJ	Technosphere	

per tonkm was calculated using assumptions on average fuel consumption (l/km) and utilisation level. The fuel is assumed to be diesel, environmental class 1. The minimum and maximum value is based on assumptions on changes in the efficiency of the engine due to degeneration. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1, given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *Change of efficiency of the engine (based on assumptions):* -minimum value: 0,99 in relation to the average engine -maximum value:1,01 in relation to the average engine									
	Output	Cargo	Cargo	1			tonne	Technosphere	
Method: See QMetaData for NOx	Output	Emission	CO	0.09		0.41	g	Air	
Date concieved: 1997-01-01 Data type: Unspecified, expert outspoke Method: The emission per tonkm was calculated from the fuel consumption using the carbon content in the diesel. ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm -CO2 emission: 73 g/MJ fuel See QMetaData for the Diesel flow for further information	Output	Emission	CO2	59	58	59	g	Air	
Method: See QMetaData for NOx	Output	Emission	HC	0.04		0.1	g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emissions per tonkm were calculated using emission factors obtained by a standardised test cycle, ECE R49 on the engine. The emission factors are given in g/kWh, where kWh refers to mechanical work done by the engine. The quantity value refer to an average engine guaranteed by Volvo Truck Corporation, the maximum value refer to emission regulations for diesel engines according to the emission standard Euro I. No minimum value was given. *The following formula was used to calculate the emissions per tonkm:* (Average fuel consumption [l/km]*thermal value[kWh (fuel)/l]*efficiency [kWh(engine)/kWh(fuel)]*emission factor [g/kWh(engine)])/(loading capacity [tonne]*utilisation level) ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption: 0,4 l/km. -Utilisation level: 70 %, of the available	Output	Emission	NOx	0.68		0.72	g	Air	

loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm *The emission factors were: Quantity value, i.e. average engine:* -NOx 7,6 g/kWh -HC 0,5 g/kWh -CO 1,0 g/kWh -Particles 0,2 g/kWh -Degree of efficiency on the engine: 40 % (assumed) The data was supplied by the Volvo Truck Corporation *Maximum value, i.e. emission standard Euro I for diesel engines:* -NOx 8 g/kWh -HC 1,1 g/kWh -CO 4,5 g/kWh -Particles 0,36 g/kWh -Degree of efficiency on the engine: 40 % (assumed) No minimum value was given. *The ECE R49 is a steady state cycle for heavy duty truck engines*. Consists of a sequence of 13 constant engine speed and load modes. Emissions are analysed for each test mode. Then the overall emission result is calculated as a (weighted) average from all test modes. The cycle is characterised by high average engine load and high exhaust gas temperature. Notes: Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially.									
Method: See QMetaData for NOx	Output	Emission	Particles	0.017			g	Air	
Date concieved: 1997-01-01 Data type: Derived, unspecified Method: The emission per tonkm was calculated from the fuel consumption using the sulphur content in the diesel ***The following data was used in the calculations:*** *Assumptions given by the Swedish Road Haulage Association:* -Average fuel consumption 0,4 l/km. -Utilisation level: 70 %, of the available loading capacity with regard to weight. *Data for the fuel, diesel environmental class 1 given by the Swedish Petroleum Institute:* -Thermal value: 43,43 MJ/kg -Density: 0,81 kg/l -Sulphur content: 10 ppm See QMetaData for the Diesel flow for further information	Output	Emission	SO2	0.00037	0.00036	0.00038	g	Air	

About Inventory	
Publication	*Energi- och emissionsuppgifter för godstransporter i Sverige. Ett konsensusdokument för övergripande jämförelser mellan transportslagen, Lägesbeskrivning november 1997,* NGM (Nätverket för Godstransporter och Miljön), (In Swedish) 1997 -- Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology Documentation reviewed by: Michael Björkman, BTL (Bilspedition Transportation and Logistics), contact person for road transports in the work of NGM --
Intended User	Suppliers and buyers of goods
General Purpose	There is an interest to compare different modes of transportation according to a joint basis. In order to be able to make correct assessments, it is crucial to have a thorough knowledge of the different function, assumptions and environmental load of different modes of transportation. The ambition within NGM (Network for goods transportation and the environment) is to compile and document all relevant environmental interventions associated with all modes of goods transportation, and to localise gaps of knowledge. The work is also intended to serve as a forum for discussion between different actors in the transportation business.

	The members of NGM consists of organisations representing road, rail, air and sea transport companies, interest groups, authority, university, research institutes etc. Example of organisations that participate in the work: BTL (Bilspedition Transportation and Logistics), ASG, SJ, FFA (The Aeronautical Research Institute of Sweden), Swedish Shipowners' Association, The Swedish Road Haulage Association, The Swedish Environmental Protection Agency, Vägverket, Sjöfartsverket, Department of Transportation and Logistics at Chalmers University of Technology, Naturskyddsföreningen
Detailed Purpose	The first step in the work of NGM was to gather available data for energy use and emissions for the operation of different modes of goods transportation. The work is conducted in working group 1 of NGM, which consists of representatives from the organisations that are members of NGM. All work is based on voluntary contributions from the representatives. The ambition was to present data for the ''best'', average and ''worst'' technology in use today. Where available, data for regular traffic would be reported, since the energy use and emissions in real transportation situations may vary greatly. The aim was also to get a picture of future energy use and emissions from transportation, through best available technology and future regulations, not yet in use.
Commissioner	- NGM (Nätverket för Godstransporter och Miljön), c/o TFK, Box 12667, S-112 93 Stockholm, Sweden.
Practitioner	Björkman, Michael - BTL (Bilspedition Transportation and Logistics), 412 97 Göteborg .
Reviewer	
Applicability	The data should not be used for detailed study of transportation. More detailed information is then needed e.g. regarding the vehicle performance, the nature of the goods, the utilisation level etc. For specific transports, the company carrying out the transport should be contacted to get information on how the goods are handled and the transport is carried out. ***Handling of goods*** Road transports generally consists of 1-3 routes: 1. Collection of the goods to terminal 2. Long-distance transport between terminals 3. Distribution of the goods from terminal The collection and distribution routes are generally performed by smaller vehicles --*Wholesale goods (>1000 kg)* are generally not handled via terminal. The goods is collected by a truck and driven straight to the customer. The truck may however collect a trailer at the terminal for further transport. --*General goods (100-1000 kg)* are generally handled via terminal. The goods may be both weight and volume limited --*Parcel goods (<100 kg)* are normally handled in small vehicles ***The following vehicles and equipages are used for transportation in Sweden:*** --*Truck max 3,5 tonnes* is mainly used for transportation of parcels. --*Light truck, max 8 tonnes* is used for local distribution, mainly in city traffic. --*Truck, max 18 tonnes* is used for district distribution and local distribution in city traffic. --*Truck, max 24 tonnes* is mainly used for transportation of general (styckegods) and wholesale (partigods) goods. --*Heavy truck with trailer, max 60 tonnes* is used for long distance transports. The towcar for the equipage is a truck, max 24 tonnes. The vehicle is not permitted in the EU and is *only used for Swedish domestic long-distance transport*. The vehicle is also permitted in Finland. --*Truck with semitrailer, max 42 tonnes* is used for international long-distance traffic. ***Utilisation level*** The data is only applicable for a utilisation level of 70 % which is representative for Swedish transports according to the Swedish Road Haulage Association and the firms of haulage that has participated in the work. It should however be noted that the average utilisation level might vary between different types of goods and firms of haulage. There are however no general rules on how to assess the utilisation level for a specific transport. There are some types of goods (e.g. timber and chemicals) that generally have an utilisation level of 50 % (i.e. full load one way and empty return trip). There may also be regional differences. The major shipping agents may be assumed to have a higher utilisation level than independent firms of haulage. The utilisation of company internal vehicles is generally low. The utilisation level includes both weight and volume limited goods, but *not empty trips*. During 1996 24 % of all transports were empty transports. Most of the empty transports (90%) were performed on distances shorter than 100 km. The share of empty trips for different types of goods during 1996 were according to SCB (Statistics Sweden): -excavated materials and round timber - 50% -manufactured products (wholesale goods) - slightly more than 20% -provisions and animal forage - approx. 15% -mixed cargo (general goods) approx - 10 %. ***The Swedish fleet*** The data for different age categories of vehicles (before 92, 1992-1995, after 96) may be used to calculate average energy use and emissions for a specific fleet or the average Swedish fleet of vehicles regarding age distribution. In Sweden, 1996 the following shares of transportation work was carried out by the different age categories: After 1996: 10 %

	95-92: 33% Before 1992 52 % The data was given by SIKA and SCB and concern vehicles larger than 3,5 tonnes. ***Bulky goods*** The data may be used for bulky goods by recalculation of the volume to an equivalent weight by the following conversion factor: 250 kg/m3. The conversion factor is generally accepted in the transportation business. ***Fuel*** The fuel used is diesel environmental class 1. According to the Swedish Petroleum Institute, the major part of all diesel fuel oil sold at present time is of class 1 (about 85% at June 1996). Class 1 diesel oil has the lowest aromatic carbon and nitrogen content of all diesel oil sold in Sweden, resulting in lower particle, carbohydrate and NOx emissions. Precombustion, i.e. extraction, refining and distribution of the fuel are not included in the system. NGM propose that data from Blinge et al Arnäs, P-O, Blinge, M., Bäckström, S., Furnander, Å. ''Livscykelanalys av drivmedel - En studie med utgångspunkt från svenska förhållanden och bästa tillgängliga teknik'', Meddelande 95, Department of Transportation and Logistics, Chalmers University of Technology, 1997 should be used. This study is based on best available technology and Swedish conditions. ***International road transports*** The data may be used for international transport if the data is recalculated for diesel environmental class 3. Generally the fleets in Europe is composed of older vehicles. The utilisation of the vehicles may also vary in different countries.
About Data	Several parameters that have a large influence on the energy use and emissions in regular traffic are not considered, e.g. climate, topography, driving technique, maintenance etc. Also, no considerations have been taken for differences in fuel consumption between different age models of vehicles. The fuel consumption for newer models are however lower. According to Greger Juhlin at Scania, the fuel consumption for heavy trucks in highway traffic has decreased from 5,7 l/km to 4 l/km during the last 15 years. The data on emissions is largely based on tests on the engine performed in a laboratory according to a *standardised test cycle*. Since exhaust emissions depend on the engine speed and load conditions, the emissions in actual operation may vary substantially. The test cycle that was used (ECE R49) is developed to represent long-distance traffic. The test cycle is thus not representative for traffic situations with extensive variations on the load conditions. A sulphur content of 10 ppm in the fuel are assumed in the calculations, which is the maximum allowed sulphur content for diesel environmental class 1. The average sulphur content in the fuel sold in Sweden is however lower: 2 ppm +/- 0,5 ppm according to the Swedish Petroleum Institute. The model to calculate the emissions may be used to represent a specific transport or firm of haulage contractors if the age of the vehicle, the fuel use for the transport, the distance and the utilisation level is known (see QMetaData).
Notes	The data is continously updated, and the data user should therefore always make sure to use the most recent version of the data, which is published on the NTM homepage: http://www.ntm.a.se. The work within NGM will continue to further increase the knowledge of different environmental interventions associated with goods transportation. The representatives for road transports (e.g. Volvo, Scania, Bilindustriföreningen, BTL Åkeriförbundet etc.) are currently compiling new data on energy use and emissions from road transports which is expected to be available in the end of February 1997. SJ and Vattenfall AB are working on new data on the environmental load of electricity production which also will be available at the end of February 1998. The major Swedish actors in the transportation business, which are members of NGM (e.g. SJ, BTL, ASG etc.), will use the data as a basis for environmental assessment of different transportation alternatives. The secretary for the work is Sebastian Bäckström, Department of Transportation and Logistics at Chalmers University of Technology.

SPINE LCI dataset: Truck, long distance transportation

Administrative	
Finished	Y

Date Completed	1994-04-01
Copyright	
Availability	Public

Technical System

Name	Truck, long distance transportation
Functional Unit	tonkm, 50 %
Functional Unit Explanation	The energy use and exhaust emissions are calculated with reference to the transportation of 1 ton goods, 1 kilometre, with an utilisation level of 50%.
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of heavy trucks and trailers with total gross weight 40-52 tonnes, used in long distance traffic. The available loading capacity with regard to weight is 25-32 tonnes.

System Boundaries

Nature Boundary	Emissions to air from combustion of the fuel are included. Other environmental impacts from the operation of the vehicle are not included.
Time Boundary	The aim was that the figures should represent the active fleet in 1992.
Geographical Boundary	Sweden and other countries with a similar fleet.
Other Boundaries	Utilisation level with regard to weight: 50%. *Excluded systems:* -Production and distribution of the fuel -Manufacture and maintenance of the vehicle -Establishment and maintenance of an infrastructure
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985-1994
Data Type	Unspecified
Represents	See 'Function'.
Method	Data compiled from different literature sources. The emissions were calculated from emission factors; the emission factor for each specific substance was multiplied with the energy use. The emission factors were: SO2 0,0094 g/MJ NOx 0,9 g/MJ CO 0,34 g/MJ CO2 73,4 g/MJ HC 0,09 g/MJ Particles 0,1 g/MJ For details on how the emission factors and energy use were obtained, see metadata for each specific substance. Metadata for NOx, CO, CO2 and HC can be found under NOx
Literature Reference	Tillman, A-M. `Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995
Notes	-

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes:	Input	Cargo	Cargo	1			tonne	Technosphere	
Date concieved: 1992 Data type: Unspecified Method: Simulation calculations conducted by AB Volvo of the energy use for heavy trucks and trailers with total weight 40-52 tonnes. Utilisation level with	Input	Refined resource	Diesel	0.9			MJ	Technosphere	

regard to weight: 50 %. The energy use are calculated as a mean value between the energy use at full load with regard to weight (25-32 tonnes) and the energy use at an empty transport. The simulations were conducted for the F12 and F16 Volvo models manufactured in 1987. The energy use for an empty truck varied between 0,26-0,31 litres/km, and at full load between 0,37-0,49 litres/km. The energy content in the fuel were 36,0 MJ/litre. Literature: de Val, D. `Schablonvärden för energiförbrukning vid godstransporter med lastbil.` Teknisk rapport, LM-54969, AB Volvo, Teknisk Utveckling, 1992 Notes: Simulation using diesel-driven Volvo trucks manufactured in 1987 was used with the aim that the values would represent an average value of the active fleets 1992. Note that the energy use for new trucks are lower. The values will therefore need to be updated regularly.									
Notes:	Output	Cargo	Cargo	1			tonne	Technosphere	
Notes:	Output	Emission	CO	0.31			g	Air	Sweden
Notes:	Output	Emission	CO2	66			g	Air	Sweden
Notes:	Output	Emission	HC	0.08			g	Air	Sweden
Date concieved: 1989-1993 Data type: Unspecified Method: The values are an average of emission factors (g/MJ) that were calculated from data found in Lenner, 1993. Emissions and energy use in Lenner were reported in g/tonkm and kWh/tonkm respectively (table 3, page 14) for two types of transports: • short distance (distribution) - an average value for 7-tonne and 14-tonne vehicles with an average load factor of 48% • long distance - 50-tonne truck with trailer with an average load factor of 60%. Emission factors in g/MJ were calculated by division of the emission factor (g/tonkm) with the energy use (kWh/tonkm) for the transport. A mean value of the calculated emission factors was then used. The figures stated by Lenner were calculated from data reported by Hammarström (1). The data in Hammarström (1) were based on measurements by the ECE R49 13-mode method, conducted by the engine exhaust laboratory of the Swedish Motor-Vehicle Inspection Co. The measurements can be found in Laveskog. The 13-mode method results in energy use and emissions in g/kWh, where kWh is related to the work done by the engine. Lenner has thus made corrections to these figures to make them represent a real traffic situation. The corrections were assumed to follow earlier relations between 13-mode data (g/kWh) and data representing a real traffic situation (g/km) described by Hammarström(2). Energy use and emissions in g/tonkm were obtained by division with the cargo weight (ton). Literature: Lenner, M. `Energiförbrukning och avgasemission` VTI meddelande nr 718, Statens Väg- och trafikinstitut 1993 (1) Hammarström U `Bränsle- och emissionsfaktorer för kallstart och varmkörda motorer` VTI notat T 119, 1992. (2) Hammarström, U. ''Trafik och avgasutsläpp - utblick mot 2015. Emissions- och bränslefaktorer för vägtrafik. VTI notat T 84, 1990. Laveskog, A ''Utsläpp från tunga dieselfordon. Mätningar 1980-1988'' Bilavgaslaboratoriet. Rapport 3579.	Output	Emission	NOx	0.81			g	Air	Sweden

Naturvårdsverket. 1989									
Date concieved: 1985 Data type: Unspecified Method: Not known. The original reference was Umweltbundesamt. The value was used in Tillman et al. Literature: Tillman A-M, Baumann, H, Eriksson, E, Rydberg, T. `Livscykelanalyser för förpackningsmaterial - beräkning av miljöbelastning`. SOU 1991:77, Allmänna förlaget, Stockholm, 1991 Umweltbundesamt, Germany, 1985	Output	Emission	Particles	0.09			g	Air	Sweden
Date concieved: 1992 Data type: Legislated limit Method: The Swedish ordinance for sulphurous fuels allows a maximum of 0.2 weight-% sulphur in diesel, equivalent to 0.094 g SO2/MJ. Literature: SFS 1987:286. ''Förordning om ändring i förordningen (1976:1055) om svavelhaltigt bränsle'' Svensk författningssamling 1987	Output	Emission	SO2	0.085			g	Air	Sweden

About Inventory

Publication	Tillman, A-M. `Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995 -- Documentation and review of the report done by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	LCA practitioners
General Purpose	To fulfil a need for standard values to calculate energy use and exhaust emissions from goods transports.
Detailed Purpose	To compile a set of standard values for energy use and exhaust emissions from available literature, and update standard values from an earlier investigation in: Tillman, A-M., Baumann, H., Eriksson, E., Rydberg, T. `Livscykelanalyser för förpackningsmaterial - beräkning av miljöbelastning` SOU 1991:77, Allmänna förlaget, Stockholm, 1991.
Commissioner	- .
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	The data are only applicable for an utilisation level of 50 %, of the available loading capacity with regard to weight. This is a conservative assumption for the level of use. An utilisation level of 50 % is however fairly representative for long-distance transport in Sweden when empty return trips are included. The utilisation level has a large influence on the energy use and emissions per tonkm. The values are intended as an average of the active fleets in 1992. The data are only intended as standard values and should not be used for detailed study of transportation.
About Data	The emissions were calculated from the energy use and emission factors. The emission factors that were used, and the basis for them can be found under QmetaData for the entire dataset.
Notes	

SPINE LCI dataset: Truck, regional distribution

Administrative

Finished	Y

Date Completed	1994-04-01
Copyright	
Availability	Public

Technical System

Name	Truck, regional distribution
Functional Unit	tonkm, 50 %
Functional Unit Explanation	The energy use and exhaust emissions are calculated with reference to the transportation of 1 ton goods, 1 kilometre for an utilisation level of 50%.
Process Type	Unit operation
Site	Sweden
Sector	Land transport
Owner	Sweden
Technical system description	Operation of medium weight trucks with a total weight of 24 tonnes, used for distribution transports.

System Boundaries

Nature Boundary	Emissions to air from combustion of the fuel are included. Other environmental impacts from the operation of the vehicle are not included.
Time Boundary	The aim was that the figures should represent the active fleet in 1992
Geographical Boundary	Sweden and other countries with a similar fleet
Other Boundaries	Utilisation level with regard to weight: 50%. *Not included in the system:* • Production and distribution of the fuel • Manufacture and maintenance of the vehicle • Establishment and maintenance of an infrastructure
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985-1994
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	Data compiled from different literature sources. The emissions were calculated from emission factors; the emission factor for each specific substance was multiplied with the energy use. The emission factors were: SO2 0,0094 g/MJ NOx 0,9 g/MJ CO 0,34 g/MJ CO2 73,4 g/MJ HC 0,09 g/MJ Particles 0,1 g/MJ For details on how the emission factors and energy use were obtained, see metadata for each specific substance. Metadata for NOx, CO, CO2 and HC can be found under NOx
Literature Reference	Tillman, A-M. \`Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.\` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995
Notes	-

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***

Notes:	Input	Cargo	Cargo	1.000000			tonne	Technosphere	
Date concieved: 1992 Data type: Modeled data Method: Simulation calculations conducted by AB Volvo of the energy use for medium weight trucks with total gross weight 24 tonnes. Utilisation level with regard to weight: 50 %. The energy use are calculated as a mean value between the energy use at full load with regard to weight (14 tonnes) and the energy use at an empty transport. The simulations were conducted for the FL10 Volvo model manufactured in 1987. The energy use for an empty truck was 0,29 litre/km, and at full load 0,39 litre/km. The energy content in the fuel were 36,0 MJ/litre. Literature: de Val, D. `Schablonvärden för energiförbrukning vid godstransporter med lastbil.` Teknisk rapport, LM-54969, AB Volvo, Teknisk Utveckling, 1992 Notes: Simulation using diesel-driven Volvo trucks manufactured in 1987 was used with the aim that the values would represent an average value of the active fleets 1992. Note that the energy use for new trucks are lower. The values will therefore need to be upupdated regularly.	Input	Refined resource	Diesel	1.7			MJ	Technosphere	
Notes:	Output	Cargo	Cargo	1.000000			tonne	Technosphere	
Notes:	Output	Emission	CO	0.58			g	Air	
Notes:	Output	Emission	CO2	125			g	Air	
Notes:	Output	Emission	HC	0.15			g	Air	
Date concieved: 1989-1993 Data type: Unspecified Method: The values are an average of emission factors (g/MJ) that were calculated from data found in Lenner, 1993. Emissions and energy use in Lenner were reported in g/tonkm and kWh/tonkm respectively (table 3, page 14) for two types of transports: • short distance (distribution) - an average value for 7-tonne and 14-tonne vehicles with an average load factor of 48% • long distance - 50-tonne truck with trailer with an average load factor of 60%. Emission factors in g/MJ were calculated by division of the emission factor (g/tonkm) with the energy use (kWh/tonkm) for the transport. A mean value of the calculated emission factors was then used. The figures stated by Lenner were calculated from data reported by Hammarström (1). The data in Hammarström (1) were based on measurements by the ECE R49 13-mode method, conducted by the engine exhaust laboratory of the Swedish Motor-Vehicle Inspection Co. The measurements can be found in Laveskog. The 13-mode method results in energy use and emissions in g/kWh, where kWh is related to the work done by the engine. Lenner has thus made corrections to these figures to make them represent a real traffic situation. The corrections were assumed to follow earlier relations between 13-mode data (g/kWh) and data representing a real traffic situation (g/km) described by Hammarström(2). Energy use and emissions in g/tonkm were obtained by division with the cargo weight (ton). Literature: Lenner, M. `Energiförbrukning och avgasemission` VTI meddelande nr 718, Statens Väg- och trafikinstitut 1993 (1) Hammarström U `Bränsle- och emissionsfaktorer för kallstart och varmkörda motorer` VTI notat T 119,	Output	Emission	NOx	1.53			g	Air	

1992. (2) Hammarström, U. ''Trafik och avgasutsläpp - utblick mot 2015. Emissions- och bränslefaktorer för vägtrafik. VTI notat T 84, 1990. Laveskog, A ''Utsläpp från tunga dieselfordon. Mätningar 1980-1988'' Bilavgaslaboratoriet. Rapport 3579. Naturvårdsverket. 1989 Notes:									
Date concieved: 1985 Data type: Unspecified Method: Not known. The original reference was Umweltbundesamt. The value was used in Tillman et al. Literature: Tillman A-M, Baumann, H, Eriksson, E, Rydberg, T. `Livscykelanalyser för förpackningsmaterial - beräkning av miljöbelastning`. SOU 1991:77, Allmänna förlaget, Stockholm, 1991 Umweltbundesamt, Germany, 1985 Notes: -	Output	Emission	Particles	0.17			g	Air	
Date concieved: 1987 Data type: Legislated limit Method: The Swedish ordinance for sulphurous fuels allows a maximum of 0.2 weight-% sulphur in diesel, equivalent to 0.094 g SO2/MJ. Literature: SFS 1987:286. ''Förordning om ändring i förordningen (1976:1055) om svavelhaltigt bränsle'' Svensk författningssamling 1987	Output	Emission	SO2	0.16			g	Air	

About Inventory	
Publication	Tillman, A-M. `Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995 -- Documentation and review of the report done by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	LCA practitioners
General Purpose	To fulfil a need for *standard values* to calculate energy use and exhaust emissions from goods transports.
Detailed Purpose	To compile a set of standard values for energy use and exhaust emissions from available literature, and update standard values from an earlier investigation in: *Tillman, A-M., Baumann, H., Eriksson, E., Rydberg, T.* `Livscykelanalyser för förpackningsmaterial - beräkning av miljöbelastning` SOU 1991:77, Allmänna förlaget, Stockholm, 1991.
Commissioner	- .
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	The data are only applicable for an utilisation level of 50 %, of the available loading capacity with regard to weight. The values are intended as an average of the active fleets in Sweden in 1992. The data are only intended as standard values and should not be used for detailed study of transportation.
About Data	The emissions were calculated from the energy use and emission factors. The emission factors that were used, and the basis for them can be found under general metadata.
Notes	

Administrative	
Finished	Y
Date Completed	1994-04-01
Copyright	
Availability	Public

Technical System	
Name	Truck, urban distribution
Functional Unit	tonkm, 50 %
Functional Unit Explanation	The energy use and exhaust emissions are calculated with reference to the transportation of 1 ton goods, 1 kilometre with an utilisation level of 50%.
Process Type	Unit operation
Site	
Sector	Land transport
Owner	
Technical system description	Operation of truck with a total gross weight of 14 tonnes, used for city distribution.

System Boundaries	
Nature Boundary	Emissions to air from combustion of the fuel are included. Other environmental impacts from the operation of the vehicle are not included.
Time Boundary	The aim was that the figures would represent the active fleet in 1992
Geographical Boundary	Sweden and other countries with a similar fleet
Other Boundaries	Utilisation level with regard to weight: 50%. *Not included in the system:* • Production and distribution of the fuel • Manufacture and maintenance of the vehicle • Establishment and maintenance of an infrastructure
Allocations	
Systems Expansions	

Flow Data	
General Activity QMetaData	
Date Conceived	1985-1994
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	Data compiled from different literature sources. The emissions were calculated from emission factors; the emission factor for each specific substance was multiplied with the energy use. The emission factors were: SO2 0,0094 g/MJ NOx 0,9 g/MJ CO 0,34 g/MJ CO2 73,4 g/MJ HC 0,09 g/MJ Particles 0,1 g/MJ For details on how the emission factors and energy use were obtained, see metadata for each specific substance. Metadata for NOx, CO, CO2 and HC can be found under NOx
Literature Reference	Tillman, A-M. `Goods transportation in life cycle assessment. **Standard values for energy consumption and emissions.` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995
Notes	-

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes:	Input	Cargo	Cargo	1.000000			tonne	Technosphere	
Date concieved: 1992 Data type: Modeled data Method: Simulation calculations conducted by AB Volvo of the energy use for trucks with total gross weight 14 tonnes. Utilisation level with regard to weight: 50 %. The energy use are calculated as a mean value between the energy use at full load with regard to weight (8,5 tonnes) and the energy use at an empty transport. The simulations were conducted for the FL6 Volvo model manufactured in 1987. The energy use for an empty truck was 0,22 litre/km, and at full load 0,31 litre/km. The energy content in the fuel were 36,0 MJ/litre. Literature: de Val, D. \`Schablonvärden för energiförbrukning vid godstransporter med lastbil.\` Teknisk rapport, LM-54969, AB Volvo, Teknisk Utveckling, 1992 Notes: Simulation using diesel-driven Volvo trucks manufactured in 1987 was used with the aim that the values would represent an average value of the active fleets in Sweden in 1992. Note that the energy use for new trucks are lower. The values will therefore need to be updated regularly	Input	Refined resource	Diesel	2.2			MJ	Technosphere	
Notes:	Output	Cargo	Cargo	1.000000			tonne	Technosphere	
Notes:	Output	Emission	CO	0.75			g	Air	
Notes:	Output	Emission	CO2	161			g	Air	
Notes:	Output	Emission	HC	0.2			g	Air	
Date concieved: 1989-1993 Data type: Unspecified Method: The values are an average of emission factors (g/MJ) that were calculated from data found in Lenner, 1993. Emissions and energy use in Lenner were reported in g/tonkm and kWh/tonkm respectively (table 3, page 14) for two types of transports: • short distance (distribution) - an average value for 7-tonne and 14-tonne vehicles with an average load factor of 48% • long distance - 50-tonne truck with trailer with an average load factor of 60%. Emission factors in g/MJ were calculated by division of the emission factor (g/tonkm) with the energy use (kWh/tonkm) for the transport. A mean value of the calculated emission factors was then used. The figures stated by Lenner were calculated from data reported by Hammarström (1). The data in Hammarström (1) were based on measurements by the ECE R49 13-mode method, conducted by the engine exhaust laboratory of the Swedish Motor-Vehicle Inspection Co. The measurements can be found in Laveskog. The 13-mode method results in energy use and emissions in g/kWh, where kWh is related to the work done by the engine. Lenner has thus made corrections to these figures to make them represent a real traffic situation. The corrections were assumed to follow earlier relations between 13-mode data (g/kWh) and data representing a real traffic situation (g/km) described by Hammarström(2). Energy use and emissions in g/tonkm were obtained by division with the cargo weight (ton). Literature: Lenner, M. \`Energiförbrukning och avgasemission\` VTI meddelande nr 718, Statens Väg- och trafikinstitut 1993	Output	Emission	NOx	1.98			g	Air	

(1) Hammarström U `Bränsle- och emissionsfaktorer för kallstart och varmkörda motorer` VTI notat T 119, 1992. (2) Hammarström, U. ''Trafik och avgasutsläpp - utblick mot 2015. Emissions- och bränslefaktorer för vägtrafik. VTI notat T 84, 1990. Laveskog, A ''Utsläpp från tunga dieselfordon. Mätningar 1980-1988'' Bilavgaslaboratoriet. Rapport 3579. Naturvårdsverket. 1989 Notes:										
Date concieved: 1985 Data type: Unspecified Represents: Method: The original reference was Umweltbundesamt. The value was used in Tillman et al. Literature: Tillman A-M, Baumann, H, Eriksson, E, Rydberg, T. `Livscykelanalyser för förpackningsmaterial - beräkning av miljöbelastning`. SOU 1991:77, Allmänna förlaget, Stockholm, 1991 Umweltbundesamt, Germany, 1985	Output	Emission	Particles	0.22			g	Air		
Date concieved: 1987 Data type: Legislated limit Method: The Swedish ordinance for sulphurous fuels allows a maximum of 0.2 weight-% sulphur in diesel, equivalent to 0.094 g SO2/MJ. Literature: SFS 1987:286. ''Förordning om ändring i förordningen (1976:1055) om svavelhaltigt bränsle'' Svensk författningssamling 1987 Notes:	Output	Emission	SO2	0.21			g	Air		

About Inventory	
Publication	Tillman, A-M. `Goods transportation in life cycle assessment. Standard values for energy consumption and emissions.` In: Life Cycle Assessment - Inventory Analysis Methodology: Overview, Recycling, Electricity and Transports, Swedish Waste Research Council (AFR) report nr 74, April 1995 -- Documentation and review of the report done by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	LCA practitioners
General Purpose	To fulfil a need for *standard values* to calculate energy use and exhaust emissions from goods transports.
Detailed Purpose	To compile a set of standard values for energy use and exhaust emissions from available literature, and update standard values from an earlier investigation in: *Tillman, A-M., Baumann, H., Eriksson, E., Rydberg, T.* `Livscykelanalyser för förpackningsmaterial - beräkning av miljöbelastning` SOU 1991:77, Allmänna förlaget, Stockholm, 1991.
Commissioner	- .
Practitioner	Tillman, Anne-Marie - Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg Sweden .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	The data are only applicable for an utilisation level of 50 %, of the available loading capacity with regard to weight. The values are intended as an average of the active fleets in Sweden in1992. The data are only intended as standard values and should not be used for detailed study of transportation.
About Data	The emissions were calculated from the energy use and emission factors. The emission factors that were used, and the basis for them can be found under general metadata.
Notes	

SPINE LCI dataset: Turkey, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	Turkey, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	Turkey
Sector	Energyware
Owner	Turkey
Technical system description	The generation of electricity with different power generating systems in Turkey during the year 1998.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	0			GWh	Technosphere	

Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	24838			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	254			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	2981			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	32707			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	42229			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	5			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	7923			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	85			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	111022			GWh	Technosphere	

About Inventory	
Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998

	Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Turning of cast iron rings

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Turning of cast iron rings
Functional Unit	9,604 kg guide ring
Functional Unit Explanation	The guide ring used in the bearing 232/530 weighs 9,604 kg. Data for this activity regards turning from 33,75 kg down to 9,604 kg guide ring.
Process Type	Unit operation
Site	SKF Mekan ABBox 89 641 21 Katrineholm
Sector	Materials and components
Owner	SKF Mekan ABBox 89 641 21 Katrineholm
Technical system description	This activity describes a process step included in the whole system activity ''Production of guide rings used for spherical roller bearings'', also available in the SPINE@CPM database. The guide ring is manufactured at SKF Mekan AB in Katrineholm and the process consists of several steps. See the activity ''Production of guide rings used for spherical roller bearings'' for details. The guide ring will finally be mounted into the SKF Spherical Roller Bearing 232/530. The function of the guide ring is to assure that the rollers stay in the raceways of the bearing. The guide ring is made of cast iron, produced mainly from scrap. After smelting of the raw materal the smelt iron is casted in a sand form. The cast iron is then further processed into guide rings. This dataset describes the turning of the cast iron rings after the casting process. ------------------------- Turning of cast iron rings: The first step in the final treatment of the guide ring is turning. In this step the ring is turned to its final shape. Iron scrap is returned as raw material and reused in the smelting process.

System Boundaries

Nature Boundary	Many of the chemicals used in the turning process are not followed from the cradle, since it was too time consuming and the impact was assumed to be very small since the total amount was very small and the substances according to product data sheets not were considered hazardous. These inflows are considered non-elementary and come from the technosphere. The mineral oil in some of the chemicals were however taken into account, and the mineral oil were followed from the cradle with the activities: ''Extraction of crude oil'' and ''Refining of crude oil''. These activities are available in the SPINE@CPM database. Many outflows were considered non-elementary and were assumed to go to the technosphere, since it was too time consuming to follow them to the grave. The iron scrap from the turning process were considered a co-product since it will be used as raw material in the smelting process, and were not followed to the grave.
Time Boundary	The data was collected during the autumn 2002 and no changes in the procedure are planned for the nearest future.
Geographical Boundary	The turning operation takes place at SKF Mekan AB in Katrineholm, Sweden
Other Boundaries	The production of electricity is NOT included in this dataset, but must be followed from the cradle in order to obtain the total environmental impact.
Allocations	Allocations were made according to weight.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Monitored data, continuous
Represents	See 'Function'.
Method	Data has been gathered from interviews and supplied material from Marja Andersson, SKF Mekan AB, in Katrineholm. She is responsible for environmental questions and much of the data comes from the environmental report from year 2001. All product data sheets for the chemicals used in the process were supplied by Marja Andersson and thus the mineral oil in the different chemicals could be taken into account and followed from the cradle (extraction and refining of crude oil). The density for mineral oil were set to 0,8 g/cm3 (source: www.physics.uc.edu)
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	5.5			kWh	Technosphere	Sweden
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: APS 2 Grease consists of >95% mineral oil according to the product data sheet.	Input	Refined resource	Grease	0.0001055			kg	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Hyspin AWS 46 contains >95 % mineral oil according to the product data sheet.	Input	Refined resource	Hyspin AWS 46	0.021			l	Technosphere	
	Input	Refined resource	Iron	33.75			kg	Technosphere	Sweden
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Magna BD 68 consists of >95% mineral oil according to the product data sheet.	Input	Refined resource	Magna BD 68	0.4219			l	Technosphere	
Date concieved: 2002 Data type: Calculated Method: All contents of mineral oil in the different chemicals were gathered into one figure so that this amount could be traced back to the cradle and be accounted for (extraction and refining of crude oil) The chemicals are still in the inventory list with the same amount, but	Input	Refined resource	mineral oil	0.3975			kg	Technosphere	

since the software LCAiT 4.0 has limitations, this was the best way to do. The substances are: Technical white (>95% mineral oil) Mgna BD 68 (>95% mineral oil) Hyspin AWS 46 (>95% mineral oil) APS 2 Grease (>95% mineral oil) The data from SKF Mekan was given in litres, and the density for mineral oil was set to 0,8 kg/l and so the weight of mineral oil could be calculated.									
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: R03 Unifett consists of: CASnr: 67-63-0 142-82-5 64742-52-5 106-97-8 74-98-6 No concentrations were reported in the product data sheet.	Input	Refined resource	R03	0.0001055			l	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Product SW 8571 contains: CASnr: Concentration: 6834-92-0 1-5 % 61791-10-4 1-5 % 7320-34-5 1-5 % according to the product data sheet.	Input	Refined resource	SW 8571	0.001055			l	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Syntila 81 contains of: Triethanolamine: 30-40 % Monoethanolamine: 1-5 % according to the product data sheet.	Input	Refined resource	Syntilo 81	0.139			l	Technosphere	
Date concieved: 02-08-01 - 02-12-31 Data type: Economical information Notes: Technical White WA 23 consists of >95% mineral oil according to the product data sheet.	Input	Refined resource	Technical white	6.328			ml	Technosphere	
	Output	Co-product	Iron scrap	10.55			kg	Technosphere	Sweden
	Output	Co-product	Iron scrap	13.6			kg	Technosphere	
	Output	Emission	Aerosols	0.000026			kg	Air	Sweden
	Output	Product	Guide ring	9.604			kg	Technosphere	Sweden
	Output	Residue	Disposal waste	0.00894			kg	Technosphere	Sweden
	Output	Residue	Emulsion	0.382			kg	Technosphere	Sweden
	Output	Residue	Grease	0.0000799			kg	Technosphere	Sweden
	Output	Residue	Industrial	0.000206			kg	Technosphere	Sweden
	Output	Residue	Oil	0.00736			kg	Technosphere	Sweden
	Output	Residue	Oil Emulsion	0.000196			kg	Technosphere	Sweden
	Output	Residue	Other paper	0.00254			kg	Technosphere	Sweden
	Output	Residue	Paper	0.0012			kg	Technosphere	Sweden
	Output	Residue	Sludge	0.0102			kg	Technosphere	Sweden
	Output	Residue	solvent	0.000118			kg	Technosphere	Sweden
	Output	Residue	Waste Incinerated	0.0107			kg	Technosphere	Sweden

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .

Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is only valid for this specific guide ring (energy consumption), in the turning process at SKF Mekan AB, Katrineholm. Data for the chemicals used in this process is valid for casted iron processed in the same turning process at this specific site.
About Data	Data is gathered from interviews with Marja Andersson, SKF Mekan AB, Katrineholm.
Notes	

SPINE LCI dataset: Turning of steel bars into bearing rollers

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Turning of steel bars into bearing rollers
Functional Unit	One turned roller: 11,44 kg
Functional Unit Explanation	For the manufacturing of one bearing roller, one turned roller is needed. The turned rollers weighs 11,44 kg. One SKF spherical roller bearing 232/530 consists of following components: 1. one inner ring 2. one outer ring 3. one guide ring 4. one brass cage 5. 36 bearing rollers (coated or non-coated)
Process Type	Unit operation
Site	SKF Sverige AB415 50 GÖTEBORG
Sector	Materials and components
Owner	SKF Sverige AB415 50 GÖTEBORG
Technical system description	This activity describes a process step included in the system ''Production of bearing rollers (à 9,2 kg)'', also available in the SPINE@CPM database. Cut steel bars (117*147 mm) from Kode, Sweden are further processed at SKFs site in Göteborg. In this activity the cut steel bars are turned in the SMT lathe into desired shape. The steel scrap is sent to Ovako Steel AB in Hofors by train, but the transport and recycling activities are NOT included in this dataset, but in the complete system: ''Production of bearing rollers à 9,2 kg''(can be found in the SPINE@CPM database) The turned rollers are after this activity sent for heat treatment and then for grinding and polishing, before they finally are mounted into the SKF spherical roller bearing 232/530.

System Boundaries	
Nature Boundary	Emissions to air are not measured and could therefore not be reported in this study. Emissions to water and the use of cutting fluid at SKF, Göteborg, could according to allocation difficulties and lack of time not be calculated. The steel scrap from the process at SKF, Göteborg is sent to Ovako Steel in Hofors for recycling and is therefore not seen as waste, but a co-product to the technosphere.
Time Boundary	The data was collected during the autumn 2002.

Geographical Boundary	The process is site specific for SKF in Göteborg, Sweden.
Other Boundaries	The electricity production is NOT included in this dataset, but must be accounted for to get the complete environmental impact. The impact from the production and disposal of the cutting fluid is not included in this dataset, since no data was available.
Allocations	Energy consumption depends on how long the rollers is processed in the different process equipment. This varies according to weight, but also according to size and desired properties of the final product.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	02-08-01 - 02-12-31
Data Type	Derived, mixed
Represents	See 'Function'.
Method	Data is gathered from interviews with Niclas Thim, SKF Large Bearings, Sweden.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Cut steel bar	12.4			kg	Technosphere	Europe
	Input	Refined resource	Electricity	0.1786			kWh	Technosphere	Sweden
	Output	Co-product	Steel scrap	0.96			kg	Technosphere	Sweden
	Output	Product	turned roller	11.44			kg	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Infomatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valild for turning of steel bars of the same material and weight and with the same processing equipment with the same energy consumption.
About Data	Data is gathered from interviews with Niclas Thim, SKF Large Bearings, Sweden.
Notes	

Administrative	
Finished	Y
Date Completed	02-12-31
Copyright	
Availability	Public

Technical System	
Name	Turning of steel rings at SKFs site in Göteborg
Functional Unit	Turned steel rings, 858.5 kg
Functional Unit Explanation	'Turned steel rings' includes one turned outer ring 232/530 OR and one turned inner ring 232/530 One turned outer ring and one turned inner ring weigh together 858,5 kg. The rings will finally be processed into bearing rings used for the SKF spherical roller bearing 232/530
Process Type	Unit operation
Site	SKF Large Bearings
Sector	Materials and components
Owner	SKF Large Bearings
Technical system description	This activity is a process step included in the system ''Production of bearing rings'', also available in the SPINE@CPM database. Turning of steel rings at SKFs site in Göteborg: The rings from Ovako Steel AB are treated further at the SKF production plant in Göteborg. The ring processes at SKF can be divided into three main steps: 1. Soft treatment 2. Hardening 3. Hard treatment For large sized bearings more work is done by hand and a smaller quantity is produced. The soft treatment starts with TURNING for both rings. The rings are turned into their final shape. For the outer ring this also means that a channel with holes for lubrication is made. For the SRB 232/530 the turning process takes place at the C-factory in production channel 23 for both rings. After the turning both the rings are inspected by ultra sound. This is done for 100% of the rings of this dimension. The reason is to make sure that the material is solid and homogenous through the whole ring. If a crack would be discovered the whole ring will be scrapped. This dataset describes the turning process. Only the amount of material is considered. The electricity consumption for the turning machine and the consumption of cutting fluid are put together with the other ring processing step at SKFs site in Göteborg and reported in the activity ''Ring processes at SKFs site in Göteborg''. The rings will be further processed in the activities: ''Heat treatment of bearing rings'' and ''Ring processes at SKFs site in Göteborg''. These activities are available in the SPINE@CPM database.

System Boundaries	
Nature Boundary	Emissions to air and water are not measured and could therefore not be reported in this study. The steel scrap from the process at SKF, Göteborg is sent to Ovako Steel in Hofors for recycling and is therefore not seen as waste, but a co-product to the technosphere.
Time Boundary	The data was collected during the autumn 2002.
Geographical Boundary	The process is site specific for SKF in Göteborg, Sweden.
Other Boundaries	The production of electricity is NOT included.
Allocations	Allocations have been made according to weight and production
Systems Expansions	Not Applicable

Flow Data

General Activity QMetaData	
Date Conceived	02-08-01 - 02-12-31
Data Type	Unspecified, guesstimate
Represents	See 'Function'.
Method	Data is estimated by Thomas Lundberg at SKF Large Bearings in Göteborg, Sweden. The electricity consumption from this activity is not considered here, but together with the electricity consumption in the activity ''Ring processes at SKFs site in Göteborg''
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Hot rolled steel rings	1154.4			kg	Technosphere	Sweden
	Output	Co-product	Steel scrap	295.9			kg	Technosphere	
	Output	Product	turned steel rings	858.5			kg	Technosphere	

About Inventory	
Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Technology, December 2002. ----------- Data documented by Helene Berg, M Sc. student at Chalmers University of Technology and SKF. Data reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-02-18.
Intended User	Product developers at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The detailed purpose for our study is to compare a coated spherical roller bearing (232/530) to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll in both cases.
Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Helene Berg - .
Reviewer	Olle Ramnäs -
Applicability	The data is valild for bearing rings of the same material and weight turned with the same processing equipment as at SKFs site in Göteborg
About Data	Data is gathered from interviews with Thomas Lundberg, SKF Large Bearings AB, Sweden.
Notes	

SPINE LCI dataset: United Kingdom, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	United Kingdom, electricity generation mix 1998

Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	United Kingdom
Sector	Energyware
Owner	United Kingdom
Technical system description	The generation of electricity with different power generating systems in the United Kingdom during the year 1998.

System Boundaries

Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	100140			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	115975			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	123040			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	5226			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	5640			GWh	Technosphere	
Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	5715			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	886			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	356622			GWh	Technosphere	

About Inventory	
Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. --- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden ---
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998 Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: United States, electricity generation mix 1998

Administrative	
Finished	Y
Date Completed	2001-01-31
Copyright	IEA
Availability	Public

Technical System	
Name	United States, electricity generation mix 1998
Functional Unit	Total electricity produced during 1998
Functional Unit Explanation	The electricity mix refer to the total amount of electricity generated by different power sources expressed in GWh during the year 1998.
Process Type	Unit operation
Site	United States
Sector	Energyware
Owner	United States
Technical system description	The generation of electricity with different power generating systems in the United States during the year 1998. United States includes Puerto rico, Guam, the Virgin Islands and the Hawaiian Free Trade Zone.

System Boundaries	
Nature Boundary	Not applicable, since the data only refer to the electricity generation mix. The environmental load for generation of electricity is not included.
Time Boundary	The data refer to 1998.
Geographical Boundary	Only electricity produced in Australia is considered. Import or export of electricity is not included.
Other Boundaries	-
Allocations	Not applicable
Systems Expansions	Not applicable

Flow Data	
General Activity QMetaData	
Date Conceived	1998
Data Type	Derived, statistics
Represents	See 'Function'.
Method	The data are collected from IEA Statistics.
Literature Reference	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8, page II.300.
Notes	See ''Represents'' for each flow to see which power generation system that are used to generate the electricity.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Date concieved: 1997 Represents: Other fuel sources	Input	Refined resource	Electricity	0			GWh	Technosphere	
Represents: Tide, wave, ocean	Input	Refined resource	Electricity	0			GWh	Technosphere	

Represents: Liquid fuels (e.g. oil), refinery gas	Input	Refined resource	Electricity	147173			GWh	Technosphere	
Represents: Geothermal	Input	Refined resource	Electricity	15369			GWh	Technosphere	
Represents: Hard coal, coke oven and blast furnace gas	Input	Refined resource	Electricity	1929428			GWh	Technosphere	
Represents: Wind	Input	Refined resource	Electricity	2926			GWh	Technosphere	
Represents: Hydro power, excl. pumped storage	Input	Refined resource	Electricity	293208			GWh	Technosphere	
Represents: Natural gas, gas works gas	Input	Refined resource	Electricity	557772			GWh	Technosphere	
Represents: Combustible renewables, wastes	Input	Refined resource	Electricity	65920			GWh	Technosphere	
Represents: Nuclear power	Input	Refined resource	Electricity	714124			GWh	Technosphere	
Represents: Lignite sub-bitumous coal, peat	Input	Refined resource	Electricity	76900			GWh	Technosphere	
Represents: Solar	Input	Refined resource	Electricity	890			GWh	Technosphere	
Represents: Total electricity production, pumped storage hydro power excluded	Output	Product	Electricity	3803710			GWh	Technosphere	

About Inventory	
Publication	IEA Statistics, Energy statistics of OECD countries 1997-1998, 2000 Edition, ISBN 92-64-05914-8. -- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden --
Intended User	LCA practitioners
General Purpose	The data is intended to be used as basis when calculating the environmental load from electricity production in OECD countries/regions.
Detailed Purpose	The specific aim for documenting the IEA statistics about electricity generation mixes in the OECD countries/regions is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines.
Commissioner	Birgit Bodlund - Vattenfall Elproduktion AB, Stockholm, Sweden .
Practitioner	Setterwall, Caroline - SwedPower AB, Stockholm, Sweden .
Reviewer	CPM -
Applicability	The environmental load may be calculated using the electricity generation mix together with LCI-data describing electricity production of different power generating systems. The power sources is found in ''Represents'' in QMetaData for each specific flow. When the electricity generation mix is used as general LCA data for the Swedish EPD system, the following data sets should be used in the calculations: - Biofuel electricity energy system, EPD-version - Fuel gas electricity energy system, EPD-version - Hydro electricity energy system, EPD-version - Lignite electricity energy system, EPD-version - Nuclear electricity energy system, EPD-version - Oil electricity energy system, EPD-version - Stone coal electricity energy system, EPD-version - Wind electricity energy system, EPD-version The following countries and regions have been documented in the database: Australia, electricity generation mix 1998 Austria, electricity generation mix 1998 Belgium, electricity generation mix 1998 Canada, electricity generation mix 1998 Czech Republic, electricity generation mix 1998 Denmark, electricity generation mix 1998 European Union, electricity generation mix 1998 Finland, electricity generation mix 1998 France, electricity generation mix 1998 Germany, electricity generation mix 1998 Greece, electricity generation mix 1998 Hungary, electricity generation mix 1998 Iceland, electricity generation mix 1998 Ireland, electricity generation mix 1998

	Italy, electricity generation mix 1998 Japan, electricity generation mix 1998 Korea, electricity generation mix 1998 Luxembourg, electricity generation mix 1998 Mexico, electricity generation mix 1998 Netherlands, electricity generation mix 1998 New Zealand, electricity generation mix 1998 Norway, electricity generation mix 1998 OECD Europe, electricity generation mix 1998 OECD North America, electricity generation mix 1998 OECD Pacific, electricity generation mix 1998 OECD total, electricity generation mix 1998 Poland, electricity generation mix 1998 Portugal, electricity generation mix 1998 Spain, electricity generation mix 1998 Sweden, electricity generation mix 1998 Switzerland, electricity generation mix 1998 Turkey, electricity generation mix 1998 United Kingdom, electricity generation mix 1998 United States, electricity generation mix 1998
About Data	
Notes	

SPINE LCI dataset: Unmodified natural gas vehicle (NGV) operating on CNG with 15 % hydrogen (HCNG-15). ESA-DBP

Administrative	
Finished	Y
Date Completed	2001/2002
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Unmodified natural gas vehicle (NGV) operating on CNG with 15 % hydrogen (HCNG-15). ESA-DBP
Functional Unit	1 vehicle km
Functional Unit Explanation	Not applicable.
Process Type	Gate to gate
Site	Unknown
Sector	Land transport
Owner	Unknown
Technical system description	Excerpts from the report (see 'Publication'): ''In 2002, APS tested a Dodge Ram Wagon Van (figure B-3) on HCNG with 15% hydrogen by volume, after it had been operated on CNG only. The test conditions and results are given in Karner and Francfort (2003a). The Dodge Ram Wagon Van is equipped from the factory for operation on CNG, and it is not further modified.'' NB: Figure B-3 and the reference (Karner and Francfort, 2003a) can be found in the publication in 'Publication'. NB: The reference (Karner and Francfort, 2003b) can be found in the publication in 'Publication'. This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf Other processes in the CPM Database also included in the above publication: 'Extraction and processing of natural gas (NG). ESA-DBP'

	'Unmodified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on CNG wiith 15 % hydrogen (HCNG-15). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on CNG wiith 30 % hydrogen (HCNG-30). ESA-DBP'

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	Data monitored in 2001/2002.
Geographical Boundary	Test made in Arizona, USA.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2001/2002
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	The emission measurements were performed according to the Federal Test Procedure (FTP-75). This test consists of three phases (cold start, transient and hot start), which cover 1,874 seconds and 17.77 kilometres at an average speed of 33.96 km/h.
Literature Reference	Karner, D. and J. E. Francfort (2003a). Dodge Ram Wagon Van - Hydrogen/CNG Operations Summary. Advanced Vehicle Testing Activity, INEEL/EXT-03-00006. Idaho Falls, USA, U.S. Department of Energy - Idaho National Laboratory.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Notes: Compressed natural gas with 15 % hydrogen	Input	Refined resource	HCNG-15	6.48			MJ	Technosphere	United States
	Output	Emission	CH4	0.119			g	Air	Arizona
	Output	Emission	CO	0.608			g	Air	Arizona
	Output	Emission	CO2	312			g	Air	Arizona
Notes: total hydrocarbons	Output	Emission	HC	0.158			g	Air	Arizona
Notes: Non-methane hydrocarbons	Output	Emission	NMHC	0.019			g	Air	Arizona
	Output	Emission	NOx	0.114			g	Air	Arizona

About Inventory

Publication	This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf
Intended User	LCA practitioners.
General Purpose	This data set is included in a master thesis. Excerpt from the master thesis abstract: ''Hydrogen is often considered as the way out of the environmental and economical problems associated with the use of fossil fuels. However, one of the main implementation barriers is the missing infrastructure. The introduction of hydrogen-blended compressed natural gas (HCNG) as a fuel for natural gas vehicles could serve as a bridging technology by using the existing natural gas infrastructure for the distribution of hydrogen.''
Detailed Purpose	Excerpt from the master thesis abstract: ''The purpose of this thesis is to assess and compare the environmental aspects of using natural gas, HCNG with 15% and 30% hydrogen by volume, and hydrogen as vehicle fuels within the scope of the proposed demonstration project.''

	Excerpt from the report (see 'Publication'): ''Since 2001, the Arizona Public Service (APS), in cooperation with Electric Transportation Applications (ETA) and the U.S. Department of Energy's Advanced Vehicle Testing Activity (ATVA), has tested different vehicles operated on CNG, HCNG and hydrogen.''
Commissioner	Not applicable - .
Practitioner	Daniel Kilgus - .
Reviewer	Karl Jonasson -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpt from the report (see 'Publication'): ''Since 2001, the Arizona Public Service (APS), in cooperation with Electric Transportation Applications (ETA) and the U.S. Department of Energy's Advanced Vehicle Testing Activity (ATVA), has tested different vehicles operated on CNG, HCNG and hydrogen. Although the tested vehicles are not commonly found on Swedish roads, the test results were used since it is assumed that comparable results of other vehicle types would mainly differ by quantity.'' ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-11-16 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Unmodified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP

Administrative	
Finished	Y
Date Completed	2001/2002
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Unmodified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP
Functional Unit	1 vehicle km
Functional Unit Explanation	Not applicable.
Process Type	Gate to gate
Site	Unknown
Sector	Land transport
Owner	Unknown
Technical system description	Excerpts from the report (see 'Publication'): ''In 2002, APS tested a Dodge Ram Wagon Van (figure B-3) on HCNG with 15% hydrogen by volume, after it had been operated on CNG only. The test conditions and results are given in Karner and Francfort (2003a). The Dodge Ram Wagon Van is equipped from the factory for operation on CNG, and it is not further modified.'' NB: Figure B-3 and the reference (Karner and Francfort, 2003a) can be found in the publication in 'Publication'. This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University

	of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf Other processes in the CPM Database also included in the above publication: 'Extraction and processing of natural gas (NG). ESA-DBP' 'Unmodified natural gas vehicle (NGV) operating on CNG wiith 15 % hydrogen (HCNG-15). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on compressed natural gas (CNG). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on CNG wiith 15 % hydrogen (HCNG-15). ESA-DBP' 'Modified natural gas vehicle (NGV) operating on CNG wiith 30 % hydrogen (HCNG-30). ESA-DBP'

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	Data monitored in 2001/2002.
Geographical Boundary	Test made in Arizona, USA.
Other Boundaries	Not applicable.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	2001/2002
Data Type	Monitored data, discrete
Represents	See 'Function'.
Method	The emission measurements were performed according to the Federal Test Procedure (FTP-75). This test consists of three phases (cold start, transient and hot start), which cover 1,874 seconds and 17.77 kilometres at an average speed of 33.96 km/h.
Literature Reference	Karner, D. and J. E. Francfort (2003a). Dodge Ram Wagon Van - Hydrogen/CNG Operations Summary. Advanced Vehicle Testing Activity, INEEL/EXT-03-00006. Idaho Falls, USA, U.S. Department of Energy - Idaho National Laboratory.
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Compressed natural gas	Input	Refined resource	CNG	6.72			MJ	Technosphere	United States
	Output	Emission	CH4	0.179			g	Air	Idaho
	Output	Emission	CO	1.36			g	Air	Idaho
	Output	Emission	CO2	351			g	Air	Idaho
Notes: total hydrocarbons	Output	Emission	HC	0.243			g	Air	
Notes: Non-methane hydrocarbons	Output	Emission	NMHC	0.0323			g	Air	Idaho
	Output	Emission	NOx	0.0597			g	Air	Idaho

About Inventory

Publication	This process is included in the system described in: Kilgus D, 2005, Life cycle assessment of a demonstration project - vehicle use of hydrogen-blended natural gas. Environmental Systems Analysis report 2005:16, Chalmers University of Technology, Gothenburg, Sweden Link to pdf (in Swedish): http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--16.pdf
Intended User	LCA practitioners.

General Purpose	This data set is included in a master thesis. Excerpt from the master thesis abstract: ''Hydrogen is often considered as the way out of the environmental and economical problems associated with the use of fossil fuels. However, one of the main implementation barriers is the missing infrastructure. The introduction of hydrogen-blended compressed natural gas (HCNG) as a fuel for natural gas vehicles could serve as a bridging technology by using the existing natural gas infrastructure for the distribution of hydrogen.''
Detailed Purpose	Excerpt from the master thesis abstract: ''The purpose of this thesis is to assess and compare the environmental aspects of using natural gas, HCNG with 15% and 30% hydrogen by volume, and hydrogen as vehicle fuels within the scope of the proposed demonstration project.'' Excerpt from the report (see 'Publication'): ''Since 2001, the Arizona Public Service (APS), in cooperation with Electric Transportation Applications (ETA) and the U.S. Department of Energy's Advanced Vehicle Testing Activity (ATVA), has tested different vehicles operated on CNG, HCNG and hydrogen.''
Commissioner	Not applicable - .
Practitioner	Daniel Kilgus - .
Reviewer	Karl Jonasson -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpt from the report (see 'Publication'): ''Since 2001, the Arizona Public Service (APS), in cooperation with Electric Transportation Applications (ETA) and the U.S. Department of Energy's Advanced Vehicle Testing Activity (ATVA), has tested different vehicles operated on CNG, HCNG and hydrogen. Although the tested vehicles are not commonly found on Swedish roads, the test results were used since it is assumed that comparable results of other vehicle types would mainly differ by quantity.'' ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-11-16 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Uranium ore extraction and enrichment. ESA-DBP

Administrative	
Finished	Y
Date Completed	1996
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Uranium ore extraction and enrichment. ESA-DBP
Functional Unit	1 kg of uranium
Functional Unit Explanation	
Process Type	Gate to gate
Site	Unknown
Sector	Mining and quarrying

Owner	Unknown
Technical system description	Excerpt from the report: ''Uranium ore is mined from both surface and underground. The processing to get uranium ore includes milling and enrichment.'' This process is included in the system described in: Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Other processes in the CPM Database also included in the above publication: - Coal mining and cleaning. ESA-DBP - Cast iron production. ESA-DBP - Limestone quarrying. ESA-DBP - Sand extraction and processing. ESA-DBP - Sinter plant's process ESA-DBP - Production of pig iron - blast furnace process. ESA-DBP

System Boundaries

Nature Boundary	The inventory analysis included parameters describing resource use (energy and raw materials) and waste generation.
Time Boundary	1994
Geographical Boundary	United Kindom
Other Boundaries	Unknown
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from the other report.
Literature Reference	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Data for particular process come from: Landbank Environmental Research & Consulting (1994), The Phosphate Report, Landbank
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity	3.00E-01			MJ	Technosphere	United Kingdom
	Input	Refined resource	Uranium ore	7.98E+01			kg	Ground	United Kingdom
	Output	Product	Enriched uranium	1.00E+00			kg	Technosphere	United Kingdom
	Output	Residue	Uranium tailings	7.88E+01			kg	Technosphere	United Kingdom

About Inventory

Publication	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden.
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The aim of the study is to undertake an LCA of typical water and sewage pumps. Those aspects which have a major contribution to the environmental impact in the life cycle of a pump will be identified.''
Detailed Purpose	Uranium is used to produce energy for production and use phase of water pump.
Commissioner	Unknown - .
Practitioner	Johanna Thuresson - .

Reviewer	Henrikke Baumann, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	

SPINE LCI dataset: Use of bearing at a paper mill

Administrative	
Finished	Y
Date Completed	2002-12-01
Copyright	
Availability	Public

Technical System	
Name	Use of bearing at a paper mill
Functional Unit	0.13 ton of bearing
Functional Unit Explanation	The function is that of a bearing at its place in the paper machine during one year. One SKF spherical roller bearing 232/530 weighs 1.2 ton. It is used for 9 years so the annual use is 0.13 ton of bearing.
Process Type	Unit operation
Site	Stora Enso Hylte ABHylte Mill S- 314 81 HYLTEBRUK Sweden
Sector	Process
Owner	Stora Enso Hylte ABHylte Mill S- 314 81 HYLTEBRUK Sweden
Technical system description	This activity describes the use of bearing at a paper mill. The bearing is used in the soft calender sector of a paper machine. One bearing 232/530 weighs 1.2 tons. It is replaced every ninth year, which means that if allocation is done by weight, 0.13 tons of bearings are therefore consumed per year. Speed: 1100 meters/minute.The bearing is lubricated with circulating oil, Mobil DTE PM 220. The lubricant is circulated at a speed of 8 liters/minute.

System Boundaries	
Nature Boundary	The inflows as well as the outflows come from the technosphere.
Time Boundary	Data is collected during autumn 2002.
Geographical Boundary	The data is case specific for Storaenso, Hyltebruk, Sweden
Other Boundaries	The energy consumption included derives from the pumping of oil in the lubricating system. The energy used to drive the roll of the paper machine (that the bearing is mounted on is not included. It was not interesting in our study since most of the friction was created from the oil surplus, and was the same in both cases.
Allocations	All in- and outflows are divided with the time period they are in use, i e lifetime. The consumption/emissions are all for the period of one year and for one bearing.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002-09-01 - 2002-12-31
Data Type	Derived, mixed
Represents	See 'Function'
Method	Interview with Dan Hedin at Storaenso, Hyltebruk.
Literature Reference	Thuresson J. (1996). Life Cycle Assessment of Water Pumps. Technical Environmental Planning, Report 1996:11 ISSN:1400-9560. Chalmers University of Technology. Gothenburg, Sweden. Data for particular process come from: Landbank Environmental Research & Consulting (1994), The Phosphate Report, Landbank
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: One SKF bearing size 232/530 weighs 1.2 ton. The lifetime is nine years which makes the annual bearing use 0.13 ton.	Input	Refine resource	Bearing	0.13			tonne	Technosphere	
Notes: The pump for the circulating system has an effect of 5 kW. The paper machine is operating non-stop all year round, i e 8760 hours a year. The electricity consumption is 8760*5 kWh, 43800 kWh. Divided on four bearings, the number for each bearing is 10950 kWh.	Input	Refine resource	Electricity	10950			kWh	Technosphere	Sweden
Notes: One filter weighs 0.706 kg and cleans the circulating oil that lubricates four bearings. The filter is replaces every six months. The annual filter use of one bearing is therefore 0.5 p filter, which is 0.353 kg.	Input	Refine resource	Filter Pall HC 8904 FKP 16Z	0.353			kg	Technosphere	Europe
Notes: The oil tank contains 3 cubic meters of oil and is replaced every eight year. Divided on four bearings, the annual consumption for each bearings is 84 kg. The density of the oil is 0.892 kg/l.	Input	Refine resource	Mobil DTE PM 220	84			kg	Technosphere	Sweden
Notes: One filter weighs 0.706 kg and cleans the circulating oil that lubricates four bearings. The filter is replaces every six months. The annual filter use of one bearing is therefore 0.5 p filter, which is 0.353 kg.	Output	Co-product	Filter Pall HC 8904 FKP 16Z	0.353			kg	Technosphere	Sweden
Notes: The oil tank contains 3 cubic meters of oil and is replaced every eight year. Divided on four bearings, the annual consumption for each bearings is 84 kg. The density of the oil is 0.892 kg/l.	Output	Emission	Mobil DTE PM 220	84			kg	Technosphere	Sweden
Notes: One SKF bearing size 232/530 weighs 1.2 ton. The lifetime is nine years which makes the annual bearing use 0.13 ton.	Output	Product	Bearing	0.13			tonne	Technosphere	

About Inventory

Publication	Master thesis: LCA based solution selection. Helene Berg and Sandra Häggström, Chalmers University of Thechnology, December 2002. -------------------- Data documented by Sandra Häggström, M Sc. student at Chalmers University of Technology and SKF. Documentation reviewed by Karolina Flemström, Industrial Environmental Informatics, Chalmers University of Technology. Published in SPINE@CPM 2003-03-21.
Intended User	Product developer at SKF.
General Purpose	The data documentation is accomplished as a part of the thesis work ''LCA-based solution selection'', performed at Chalmers University of Technology by Helene Berg and Sandra Häggström.
Detailed Purpose	The purpose for our study is to compare a coated roller bearing to a non-coated, from cradle to grave. We have chosen paper machines as user phase. The bearing is mounted on a soft calender roll and is lubricated with a circulating oil system in both cases.

Commissioner	Victoria Wikström - SKF Sverige AB D1S3 415 50 Göteborg .
Practitioner	Sandra Häggström - .
Reviewer	Olle Ramnäs -
Applicability	The data is applicable for bearings used in the soft calender in a paper machine.
About Data	The data is gathered interviewing Dan Hedin on a visit at Storaenso, Hyltebruk.
Notes	

SPINE LCI dataset: Use phase of train bearings - train type 'Regina'. ESA-DBP

Administrative	
Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Use phase of train bearings - train type 'Regina'. ESA-DBP
Functional Unit	2 axleboxes with bearings on a distance of 100 000km
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. The functional unit (fu) is here defined as 2 axleboxes with bearings, mounted on a wheel axle in use on its matched Electric Multiple Unit (EMU) during 100 000 km of transport. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year.''
Process Type	Gate to gate
Site	SKF Sverige AB 415 50 Göteborg
Sector	Land transport
Owner	SKF Sverige AB 415 50 Göteborg
Technical system description	The study was done for a a train 'Regina' which is manufactured by Adtranz, today Bombardier Transportation, since the year 2000. In this kind of train pre-lubricated, sealed Tapered Bearing Units, so-called TBUs are used. The Reginas are used on the Swedish West coast, in Mälardalen and in Bergslagen. Excerpt from the study, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. (...) The Regina TBU is named 1639605 C and contains the bearing BT2B 641157 CB. The axlebox has the number 432758. (...) In this study, the use-phase of train bearings involves the time the bearings are in operation on an EMU (NB: Electric Multiple Unit) wheel axle and the processes for wheel axle refurbishment when needed. (...) The main processes discussed in the study are production, operation, maintenance and transports of train bearings. For the maintenance process, there is a number of sub-processes called dismounting of wheel axle, detergent production, naphtha production, lubricating oil and grease production, local processes, and waste oil handling. Local processes denote electricity use of tools and machines at the refurbishment site. For Regina, the TBU is filled with grease and sealed at the SKF factory and no grease is added when the TBU and the axlebox are mounted on the axle. (...) If there is no leakage from the axlebox, the only environmental impact caused by train bearings in operation is related to noise, vibration and energy use because of friction between bearing parts. The consequences of the energy use depend on the energy source, which is electricity for all EMUs. (...) For maintenance of train bearings, the wheel axle is dismounted from the train car, and the axlebox and the bearings are dismounted from the axle. The different parts are cleaned, washed, refurbished, relubricated and finally

	remounted on the axle. The environmental impact of these activities, and the transports between them, is related to the use of electricity, detergents and oil products, and the discharge of greenhouse gases, toxic material and polluting substances.'' This process is included in the system described in: Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf Other processes in the CPM Database also included in the above publication: - Operation on train bearings - train type 'X1'. ESA-DBP - Operation on train bearings - train type 'X10'. ESA-DBP - Operation on train bearings - train type 'Regina'. ESA-DBP - Maintenance of train bearings - train type 'X1'. ESA-DBP - Maintenance of train bearings - train type 'X10'. ESA-DBP - Maintenance of train bearings - train type 'Regina'. ESA-DBP - Use phase of train bearings - train type 'X1'. ESA-DBP - Use phase of train bearings - train type 'X10'. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''The environmental impact of the whole life cycle, from cradle to grave, for products used during the use-phase of the bearings is thus included, while production and recycling of bearings, and distribution of new and discarded bearings are not. (...) The one environmental aspect considered for train bearings in operation is electricity use. (...) Land, water and other types of resource use could not be assessed, due to lack of data.''
Time Boundary	Excerpt from the report, see 'Publication': ''The study is intended to illustrate the present situation, and the qualitative and quantitative information for the main processes are from the year 2001 until today. (NB: the report was written in 2003)
Geographical Boundary	Excerpt from the report, see 'Publication': ''All the studied trains are in use in Sweden, where most of the maintenance is performed, too. (...) The operation and maintenance processes were mapped with regard to the specific sub-processes at the Swedish and Italian sites.
Other Boundaries	Excerpt from the report, see 'Publication': ''The mass of passengers is neglected, but corresponds to roughly 10 percent of the duty mass if the train is half-filled. The ambient temperature used in the calculations was 10 degrees centigrade. Noise and vibration were not studied, and other environmental aspects of railway traffic operation were not regarded as being clearly related to the use of bearings. The environmental effects of industrial buildings, production of tools and machines, and the use of human labour are not included. (...) The lifetime of train bearings is not included in the study, as this primarily would affect the environmental impact of the production-phase in that a differing number of bearings would be needed to maintain the same function. It is thus included in the production-phase in the comparison with the operation, maintenance and transports processes. The lifetime of bearings is generally given as basic rating life (L10h), which is 'the life that 90 percent of a sufficiently large group of apparently identical bearings can be expected to attain or exceed'.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''The data has been collected through visits and interviews. (...) Most data are estimates made by responsible personnel at the different sites, as there seldom is any information available, that is detailed enough for the purpose of an LCA. The estimates are combined with data from product data sheets and published LCA literature, to give a realistic approximation of the actual conditions. The electricity use for train bearings in operation was calculated with the computer program SKF Galaxy.''
Literature Reference	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2003--3.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data									
QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity (accounted)	2.23E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity (non-accounted)	6.15E+03			MJ	Technosphere	Sweden
	Input	Refined resource	Feedstock energy	1.04E+01			MJ	Technosphere	Sweden
	Output	Emission	Acid H+	1.04E-02			g	Water	Sweden
	Output	Emission	Al	1.19E-03			g	Water	Sweden
	Output	Emission	Aluminium sulphate	7.66E-03			g	Water	Sweden
	Output	Emission	AOX as Cl-	2.45E-05			g	Water	Sweden
	Output	Emission	Aromatic HC	1.14E-04			g	Air	Sweden
	Output	Emission	Aromatic HC	4.25E-04			g	Water	Sweden
	Output	Emission	Arsenic	2.52E-06			g	Water	Sweden
	Output	Emission	As	3.72E-08			g	Air	Sweden
	Output	Emission	Assay Al2O3	4.37E-02			g	Water	Sweden
	Output	Emission	Ba	5.16E-04			g	Water	Sweden
	Output	Emission	Be	4.65E-10			g	Air	Sweden
	Output	Emission	Benzene	8.01E-05			g	Air	Sweden
	Output	Emission	BOD	4.47E-03			g	Water	Sweden
	Output	Emission	Cd	2.43E-06			g	Air	Sweden
	Output	Emission	Cd	4.65E-05			g	Water	Sweden
	Output	Emission	CH4	3.02E+02			g	Air	Sweden
	Output	Emission	Chlorinated CH	1.97E-07			g	Water	Sweden
	Output	Emission	Cl-	9.54E+00			g	Water	Sweden
	Output	Emission	CN-	6.72E-07			g	Water	Sweden
	Output	Emission	CO	1.12E+02			g	Air	Sweden
	Output	Emission	Co	4.65E-09			g	Water	Sweden
	Output	Emission	CO2	5.29E+04			g	Air	Sweden
	Output	Emission	COD	2.07E-01			g	Water	Sweden
	Output	Emission	Cr	3.25E-08			g	Air	Sweden
	Output	Emission	Cr	3.82E-05			g	Water	Sweden
	Output	Emission	Cu	1.30E-07			g	Air	Sweden
	Output	Emission	Cu	6.21E-06			g	Water	Sweden
	Output	Emission	Dimethyl-aminoacrylate	6.53E-04			g	Water	Sweden
	Output	Emission	Dioxin	4.65E-14			g	Water	Sweden
	Output	Emission	Dioxin	6.65E-15			g	Air	Sweden
	Output	Emission	Dissolved solids	6.63E-04			g	Water	Sweden
	Output	Emission	DOC	4.87E-05			g	Water	Sweden
	Output	Emission	Dust	1.63E+01			g	Air	Sweden
	Output	Emission	F-	8.13E-01			g	Water	Sweden
	Output	Emission	Fat	6.01E-03			g	Water	Sweden
	Output	Emission	Fe	2.03E-02			g	Water	Sweden
	Output	Emission	H2SO4	1.07E-02			g	Water	Sweden
	Output	Emission	Halogenated HC	1.11E-09			g	Air	Sweden
	Output	Emission	Halon H1301	8.02E-07			g	Air	Sweden
	Output	Emission	HC	4.56E-03			g	Water	Sweden
	Output	Emission	HCl	5.13E-03			g	Air	Sweden
	Output	Emission	HCl	6.74E-03			g	Water	Sweden
	Output	Emission	HF	8.08E-05			g	Air	Sweden
	Output	Emission	Hg	1.34E-08			g	Water	Sweden
	Output	Emission	Hg	3.79E-07			g	Air	Sweden
	Output	Emission	HNO3	2.68E-03			g	Water	Sweden
	Output	Emission	Inorganic salts and acids	5.59E+00			g	Water	Sweden
	Output	Emission	Metals	3.41E-03			g	Water	Sweden
	Output	Emission	Metals	7.92E-04			g	Air	Sweden
	Output	Emission	Mn	6.75E-07			g	Air	Sweden
	Output	Emission	N2O	4.55E+00			g	Air	Sweden
	Output	Emission	NaOH	1.44E-02			g	Water	Sweden
	Output	Emission	NH3	1.36E+00			g	Air	Sweden
	Output	Emission	NH4+	3.27E-03			g	Water	Sweden
	Output	Emission	Ni	1.75E-04			g	Water	Sweden
	Output	Emission	Ni	6.01E-05			g	Air	Sweden
	Output	Emission	Nitrogen organic bound	2.44E-05			g	Water	Sweden
	Output	Emission	NMVOC non-methane HC	2.12E+01			g	Air	Sweden
	Output	Emission	NO2	1.37E+02			g	Air	Sweden

	Output	Emission	NO3-	3.54E-04			g	Water	Sweden
	Output	Emission	NTA solution (100%)	1.29E-04			g	Water	Sweden
	Output	Emission	N-tot	4.27E-04			g	Water	Sweden
	Output	Emission	PAH policycl. Arom. HC	2.19E-06			g	Water	Sweden
	Output	Emission	PAH policycl. Arom. HC	8.62E-02			g	Air	Sweden
	Output	Emission	Pb	6.92E-06			g	Air	Sweden
	Output	Emission	Pb	8.56E-06			g	Water	Sweden
	Output	Emission	Phenol	2.66E-04			g	Water	Sweden
	Output	Emission	PO43-	8.06E-05			g	Water	Sweden
	Output	Emission	Potasium hydroxite (KOH)	1.51E-03			g	Water	Sweden
	Output	Emission	Radioactive emissions	3.41E-02			g	Water	Sweden
	Output	Emission	Radioactive emissions	3.69E+00			g	Air	Sweden
	Output	Emission	S2-	7.63E-05			g	Water	Sweden
	Output	Emission	Silicates	1.09E-02			g	Water	Sweden
	Output	Emission	SO2	8.21E+01			g	Air	Sweden
	Output	Emission	SO42-	7.17E-02			g	Water	Sweden
	Output	Emission	Sodium gluconate	3.70E-04			g	Water	Sweden
	Output	Emission	Sodium hypochlorite	3.73E-04			g	Water	Sweden
	Output	Emission	Sodium ions	5.43E-02			g	Water	Sweden
	Output	Emission	Sodium kapryl-aminodipropionate	8.40E-04			g	Water	Sweden
	Output	Emission	Suspended solids	3.29E+01			g	Water	Sweden
	Output	Emission	TEX (aliphatic)	1.84E-03			g	Water	Sweden
	Output	Emission	TOC	4.64E-03			g	Water	Sweden
	Output	Emission	Toluene	2.04E-05			g	Water	Sweden
	Output	Emission	Tridecylalkoholetoxilat	8.40E-04			g	Water	Sweden
	Output	Emission	Zn	7.48E-04			g	Water	Sweden
	Output	Emission	Zn	9.72E-06			g	Air	Sweden
	Output	Residue	Solid waste	8.00E+01			kg	Technosphere	Sweden
	Output	Residue	Waste water	6.68E+00			m3	Technosphere	Sweden

About Inventory

Publication	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this LCA is to investigate the environmental impact of the use-phase for bearings in trains. Three generations of trains, so-called Electrical Multiple Units (EMUs), will be studied, and comparison will be made between processes within the life cycle of the bearings, and between the bearings in the different generations of EMUs.''
Detailed Purpose	Unknown
Commissioner	SKF Sverige AB - 415 50 Göteborg .
Practitioner	Karl Jonasson - .
Reviewer	Björn Andersson, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report, see 'Publication': ''SKF provides both bearings and bearing housings for trains, called axleboxes, which are mounted in direct connection with the train's wheels to make the wheel axle able to rotate (...). The bearings used for this purpose are in this study referred to as 'train bearings', even though there are other fields of application for bearings in trains (e.g. in the traction system). What type of rolling bearings used for the wheel axle varies according to performance needs and train design, but the function is essentially the same.''

SPINE LCI dataset: Use phase of train bearings - train type 'X1'. ESA-DBP

Administrative	
Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Use phase of train bearings - train type 'X1'. ESA-DBP
Functional Unit	2 axleboxes with bearings on a distance of 100 000km
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. The functional unit (fu) is here defined as 2 axleboxes with bearings, mounted on a wheel axle in use on its matched Electric Multiple Unit (EMU) during 100 000 km of transport. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year.''
Process Type	Gate to gate
Site	SKF Sverige AB 415 50 Göteborg
Sector	Land transport
Owner	SKF Sverige AB 415 50 Göteborg
Technical system description	The study was done for a a train 'X1' which was manufactured by ASEA during the years 1967-1975. In this kind of train an un-sealed Spherical Roller Bearings (SRBs) were used. More than 100 of X1s were produced and most of them are still in use especially in Stokholm area. Excerpt from the study, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. (...) The SRB used in X1-A, X1-B and X10 has the SKF product number 23226 CC/C3W33, and the axleboxes are called 723724, 723721 and 4000850 respectively. (...) In this study, the use-phase of train bearings involves the time the bearings are in operation on an EMU (NB: Electric Multiple Unit) wheel axle and the processes for wheel axle refurbishment when needed. (...) The main processes discussed in the study are production, operation, maintenance and transports of train bearings. For the maintenance process, there is a number of sub-processes called dismounting of wheel axle, detergent production, naphtha production, lubricating oil and grease production, local processes, and waste oil handling. Local processes denote electricity use of tools and machines at the refurbishment site. When mounted on a X1 (...), the axlebox with its one or two bearings is filled with grease and sealed, to keep the grease inside and water and dirt outside the box. Thus no lubrication is needed while the bearing is in operation, and the axlebox is only opened when the whole wheel axle is dismounted for maintenance. If there is no leakage from the axlebox, the only environmental impact caused by train bearings in operation is related to noise, vibration and energy use because of friction between bearing parts. The consequences of the energy use depend on the energy source, which is electricity for all EMUs. (...) For maintenance of train bearings, the wheel axle is dismounted from the train car, and the axlebox and the bearings are dismounted from the axle. The different parts are cleaned, washed, refurbished, relubricated and finally remounted on the axle. The environmental impact of these activities, and the transports between them, is related to the use of electricity, detergents and oil products, and the discharge of greenhouse gases, toxic material and polluting substances. This process is included in the system described in: Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF:

	http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf Other processes in the CPM Database also included in the above publication: - Operation on train bearings - train type 'X1'. ESA-DBP - Operation on train bearings - train type 'X10'. ESA-DBP - Operation on train bearings - train type 'Regina'. ESA-DBP - Maintenance of train bearings - train type 'X1'. ESA-DBP - Maintenance of train bearings - train type 'X10'. ESA-DBP - Maintenance of train bearings - train type 'Regina'. ESA-DBP - Use phase of train bearings - train type 'X10'. ESA-DBP - Use phase of train bearings - train type 'Regina'. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': ''The environmental impact of the whole life cycle, from cradle to grave, for products used during the use-phase of the bearings is thus included, while production and recycling of bearings, and distribution of new and discarded bearings are not. (...) The one environmental aspect considered for train bearings in operation is electricity use. (...) Land, water and other types of resource use could not be assessed, due to lack of data.''
Time Boundary	Excerpt from the report, see 'Publication': ''The study is intended to illustrate the present situation, and the qualitative and quantitative information for the main processes are from the year 2001 until today. (NB: the report was written in 2003)
Geographical Boundary	Excerpt from the report, see 'Publication': ''All the studied trains are in use in Sweden, where most of the maintenance is performed, too. (...) The operation and maintenance processes were mapped with regard to the specific sub-processes at the Swedish and Italian sites.
Other Boundaries	Excerpt from the report, see 'Publication': ''The mass of passengers is neglected, but corresponds to roughly 10 percent of the duty mass if the train is half-filled. The ambient temperature used in the calculations was 10 degrees centigrade. (...) The total efficiency of the electrical supply system is 81.8 percent for X1 and X10. (...) Noise and vibration were not studied, and other environmental aspects of railway traffic operation were not regarded as being clearly related to the use of bearings. The environmental effects of industrial buildings, production of tools and machines, and the use of human labour are not included. (...) The lifetime of train bearings is not included in the study, as this primarily would affect the environmental impact of the production-phase in that a differing number of bearings would be needed to maintain the same function. It is thus included in the production-phase in the comparison with the operation, maintenance and transports processes. The lifetime of bearings is generally given as basic rating life (L10h), which is 'the life that 90 percent of a sufficiently large group of apparently identical bearings can be expected to attain or exceed'.''
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': ''The data has been collected through visits and interviews. (...) Most data are estimates made by responsible personnel at the different sites, as there seldom is any information available, that is detailed enough for the purpose of an LCA. The estimates are combined with data from product data sheets and published LCA literature, to give a realistic approximation of the actual conditions. The electricity use for train bearings in operation was calculated with the computer program SKF Galaxy.''
Literature Reference	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2003--3.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Electricity (accounted)	1.93E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity (non-accounted)	6.75E+03			MJ	Technosphere	Sweden
	Input	Refined resource	Feedstock energy	3.10E+01			MJ	Technosphere	Sweden

	Output	Emission	Acid H+	2.33E-02			g	Water	Sweden
	Output	Emission	Al	8.96E-04			g	Water	Sweden
	Output	Emission	Aluminium sulphate	2.31E-02			g	Water	Sweden
	Output	Emission	AOX as Cl-	7.27E-05			g	Water	Sweden
	Output	Emission	Aromatic HC	8.58E-05			g	Air	Sweden
	Output	Emission	Aromatic HC	9.45E-04			g	Water	Sweden
	Output	Emission	Arsenic	1.89E-06			g	Water	Sweden
	Output	Emission	As	1.12E-07			g	Air	Sweden
	Output	Emission	Assay Al2O3	1.32E-02			g	Water	Sweden
	Output	Emission	Ba	3.87E-04			g	Water	Sweden
	Output	Emission	Be	1.40E-09			g	Air	Sweden
	Output	Emission	Benzene	6.01E-05			g	Air	Sweden
	Output	Emission	BOD	5.93E-03			g	Water	Sweden
	Output	Emission	Cd	1.88E-06			g	Air	Sweden
	Output	Emission	Cd	3.57E-05			g	Water	Sweden
	Output	Emission	CH4	3.31E+02			g	Air	Sweden
	Output	Emission	Chlorinated CH	1.48E-07			g	Water	Sweden
	Output	Emission	Cl-	7.27E+00			g	Water	Sweden
	Output	Emission	CN-	5.04E-07			g	Water	Sweden
	Output	Emission	CO	1.22E+02			g	Air	Sweden
	Output	Emission	Co	1.40E-08			g	Water	Sweden
	Output	Emission	CO2	5.72E+04			g	Air	Sweden
	Output	Emission	COD	6.10E-01			g	Water	Sweden
	Output	Emission	Cr	4.69E-05			g	Water	Sweden
	Output	Emission	Cr	9.82E-08			g	Air	Sweden
	Output	Emission	Cu	3.93E-07			g	Air	Sweden
	Output	Emission	Cu	4.66E-06			g	Water	Sweden
	Output	Emission	Dimethyl-aminoacrylate	1.97E-03			g	Water	Sweden
	Output	Emission	Dioxin	1.40E-13			g	Water	Sweden
	Output	Emission	Dioxin	2.01E-14			g	Air	Sweden
	Output	Emission	Dissolved solids	4.97E-04			g	Water	Sweden
	Output	Emission	DOC	3.65E-05			g	Water	Sweden
	Output	Emission	Dust	1.79E+01			g	Air	Sweden
	Output	Emission	F-	6.10E-01			g	Water	Sweden
	Output	Emission	Fat	7.71E-03			g	Water	Sweden
	Output	Emission	Fe	5.88E-02			g	Water	Sweden
	Output	Emission	H2SO4	3.22E-02			g	Water	Sweden
	Output	Emission	Halogenated HC	8.33E-10			g	Air	Sweden
	Output	Emission	Halon H1301	6.02E-07			g	Air	Sweden
	Output	Emission	HC	1.38E-02			g	Water	Sweden
	Output	Emission	HCl	2.04E-02			g	Water	Sweden
	Output	Emission	HCl	6.90E-03			g	Air	Sweden
	Output	Emission	HF	6.06E-05			g	Air	Sweden
	Output	Emission	Hg	1.04E-08			g	Water	Sweden
	Output	Emission	Hg	4.85E-07			g	Air	Sweden
	Output	Emission	HNO3	8.07E-03			g	Water	Sweden
	Output	Emission	Inorganic salts and acids	4.19E+00			g	Water	Sweden
	Output	Emission	Metals	1.11E-03			g	Air	Sweden
	Output	Emission	Metals	5.14E-03			g	Water	Sweden
	Output	Emission	Mn	5.07E-07			g	Air	Sweden
	Output	Emission	N2O	4.95E+00			g	Air	Sweden
	Output	Emission	NaOH	4.34E-02			g	Water	Sweden
	Output	Emission	NH3	1.49E+00			g	Air	Sweden
	Output	Emission	NH4+	2.97E-03			g	Water	Sweden
	Output	Emission	Ni	4.52E-05			g	Air	Sweden
	Output	Emission	Ni	5.14E-04			g	Water	Sweden
	Output	Emission	Nitrogen organic bound	1.83E-05			g	Water	Sweden
	Output	Emission	NMVOC non-methane HC	2.41E+01			g	Air	Sweden
	Output	Emission	NO2	1.42E+02			g	Air	Sweden
	Output	Emission	NO3-	7.82E-04			g	Water	Sweden
	Output	Emission	NTA solution (100%)	3.88E-04			g	Water	Sweden
	Output	Emission	N-tot	8.37E-04			g	Water	Sweden
	Output	Emission	PAH policycl. Arom. HC	1.65E-06			g	Water	Sweden
	Output	Emission	PAH policycl. Arom. HC	6.46E-02			g	Air	Sweden
	Output	Emission	Pb	1.02E-05			g	Water	Sweden

	Output	Emission	Pb	7.14E-06			g	Air	Sweden
	Output	Emission	Phenol	7.47E-04			g	Water	Sweden
	Output	Emission	PO43-	6.05E-05			g	Water	Sweden
	Output	Emission	Potasium hydroxite (KOH)	4.56E-03			g	Water	Sweden
	Output	Emission	Radioactive emissions	2.55E-02			g	Water	Sweden
	Output	Emission	Radioactive emissions	2.77E+00			g	Air	Sweden
	Output	Emission	S2-	6.88E-05			g	Water	Sweden
	Output	Emission	Silicates	8.15E-03			g	Water	Sweden
	Output	Emission	SO2	9.05E+01			g	Air	Sweden
	Output	Emission	SO42-	5.50E-02			g	Water	Sweden
	Output	Emission	Sodium gluconate	1.12E-03			g	Water	Sweden
	Output	Emission	Sodium hypochlorite	1.12E-03			g	Water	Sweden
	Output	Emission	Sodium ions	4.08E-02			g	Water	Sweden
	Output	Emission	Sodium kapryl-aminodipropionate	2.53E-03			g	Water	Sweden
	Output	Emission	Suspended solids	2.48E+01			g	Water	Sweden
	Output	Emission	TEX (aliphatic)	5.56E-03			g	Water	Sweden
	Output	Emission	TOC	3.48E-03			g	Water	Sweden
	Output	Emission	Toluene	1.53E-05			g	Water	Sweden
	Output	Emission	Tridecylalkoholetoxilat	2.53E-03			g	Water	Sweden
	Output	Emission	Zn	1.21E-05			g	Air	Sweden
	Output	Emission	Zn	9.15E-04			g	Water	Sweden
	Output	Residue	Solid waste	8.78E+01			kg	Technosphere	Sweden
	Output	Residue	Waste water	1.73E-03			m3	Technosphere	Sweden

About Inventory

Publication	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this LCA is to investigate the environmental impact of the use-phase for bearings in trains. Three generations of trains, so-called Electrical Multiple Units (EMUs), will be studied, and comparison will be made between processes within the life cycle of the bearings, and between the bearings in the different generations of EMUs.''
Detailed Purpose	Unknown
Commissioner	SKF Sverige AB - 415 50 Göteborg .
Practitioner	Karl Jonasson - .
Reviewer	Björn Andersson, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report, see 'Publication': ''SKF provides both bearings and bearing housings for trains, called axleboxes, which are mounted in direct connection with the train's wheels to make the wheel axle able to rotate (...). The bearings used for this purpose are in this study referred to as 'train bearings', even though there are other fields of application for bearings in trains (e.g. in the traction system). What type of rolling bearings used for the wheel axle varies according to performance needs and train design, but the function is essentially the same.''

SPINE LCI dataset: Use phase of train bearings - train type 'X10'. ESA-DBP

Administrative	
Finished	Y
Date Completed	2003
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Use phase of train bearings - train type 'X10'. ESA-DBP
Functional Unit	2 axleboxes with bearings on a distance of 100 000km
Functional Unit Explanation	Excerpt from the report, see 'Publication': ''The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. The functional unit (fu) is here defined as 2 axleboxes with bearings, mounted on a wheel axle in use on its matched Electric Multiple Unit (EMU) during 100 000 km of transport. (...) For the calculations a maintenance interval of 500 000 km is assumed for the bearings, which implies maintenance every fifth year if the EMUs are run 100 000 km per year.''
Process Type	Gate to gate
Site	SKF Sverige AB 415 50 Göteborg
Sector	Land transport
Owner	SKF Sverige AB 415 50 Göteborg
Technical system description	The study was done for a a train 'X10' which was manufactured by ASEA/ABB Traction during the years 1982-1993. In this kind of train an un-sealed Spherical Roller Bearings (SRBs) were used. More than 100 of X10s were produced and most of them are still in use especially in Stokholm, Gotheburg and Skåne area. Excerpt from the study, see 'Publication': ''During the 1990s some of the X10s were rebuilt with a different interior, and renamed to X11. These are also included under the designation X10 in this study, as the basic performance is the same. (...) The function of bearings in train wheels is to be the link between wheel axle and train car, and make the axle able to rotate. (...) The SRB used in X1-A, X1-B and X10 has the SKF product number 23226 CC/C3W33, and the axleboxes are called 723724, 723721 and 4000850 respectively. (...) In this study, the use-phase of train bearings involves the time the bearings are in operation on an EMU (NB: Electric Multiple Unit) wheel axle and the processes for wheel axle refurbishment when needed. (...) The main processes discussed in the study are production, operation, maintenance and transports of train bearings. For the maintenance process, there is a number of sub-processes called dismounting of wheel axle, detergent production, naphtha production, lubricating oil and grease production, local processes, and waste oil handling. Local processes denote electricity use of tools and machines at the refurbishment site. When mounted on a X10 (...), the axlebox with its one or two bearings is filled with grease and sealed, to keep the grease inside and water and dirt outside the box. Thus no lubrication is needed while the bearing is in operation, and the axlebox is only opened when the whole wheel axle is dismounted for maintenance. If there is no leakage from the axlebox, the only environmental impact caused by train bearings in operation is related to noise, vibration and energy use because of friction between bearing parts. The consequences of the energy use depend on the energy source, which is electricity for all EMUs. (...) For maintenance of train bearings, the wheel axle is dismounted from the train car, and the axlebox and the bearings are dismounted from the axle. The different parts are cleaned, washed, refurbished, relubricated and finally remounted on the axle. The environmental impact of these activities, and the transports between them, is related to the use of electricity, detergents and oil products, and the discharge of greenhouse gases, toxic material and polluting substances.'' This process is included in the system described in: Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf Other processes in the CPM Database also included in the above publication: - Operation on train bearings - train type 'X1'. ESA-DBP - Operation on train bearings - train type 'X10'. ESA-DBP

	- Operation on train bearings - train type 'Regina'. ESA-DBP - Maintenance of train bearings - train type 'X1'. ESA-DBP - Maintenance of train bearings - train type 'X10'. ESA-DBP - Maintenance of train bearings - train type 'Regina'. ESA-DBP - Use phase of train bearings - train type 'X1'. ESA-DBP - Use phase of train bearings - train type 'Regina'. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report, see 'Publication': "The environmental impact of the whole life cycle, from cradle to grave, for products used during the use-phase of the bearings is thus included, while production and recycling of bearings, and distribution of new and discarded bearings are not. (...) The one environmental aspect considered for train bearings in operation is electricity use. (...) Land, water and other types of resource use could not be assessed, due to lack of data."
Time Boundary	Excerpt from the report, see 'Publication': "The study is intended to illustrate the present situation, and the qualitative and quantitative information for the main processes are from the year 2001 until today. (NB: the report was written in 2003)
Geographical Boundary	Excerpt from the report, see 'Publication': "All the studied trains are in use in Sweden, where most of the maintenance is performed, too. (...) The operation and maintenance processes were mapped with regard to the specific sub-processes at the Swedish and Italian sites.
Other Boundaries	Excerpt from the report, see 'Publication': "The mass of passengers is neglected, but corresponds to roughly 10 percent of the duty mass if the train is half-filled. The ambient temperature used in the calculations was 10 degrees centigrade. Noise and vibration were not studied, and other environmental aspects of railway traffic operation were not regarded as being clearly related to the use of bearings. The environmental effects of industrial buildings, production of tools and machines, and the use of human labour are not included. (...) The lifetime of train bearings is not included in the study, as this primarily would affect the environmental impact of the production-phase in that a differing number of bearings would be needed to maintain the same function. It is thus included in the production-phase in the comparison with the operation, maintenance and transports processes. The lifetime of bearings is generally given as basic rating life (L10h), which is 'the life that 90 percent of a sufficiently large group of apparently identical bearings can be expected to attain or exceed'."
Allocations	Unknown
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2002
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Excerpt from the report, see 'Publication': "The data has been collected through visits and interviews. (...) Most data are estimates made by responsible personnel at the different sites, as there seldom is any information available, that is detailed enough for the purpose of an LCA. The estimates are combined with data from product data sheets and published LCA literature, to give a realistic approximation of the actual conditions. The electricity use for train bearings in operation was calculated with the computer program SKF Galaxy."
Literature Reference	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2003--3.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Refined resource	Electricity (accounted)	1.93E-01			MJ	Technosphere	Sweden
	Input	Refined resource	Electricity (non-accounted)	9.00E+03			MJ	Technosphere	Sweden
	Input	Refined resource	Feedstock energy	3.10E+01			MJ	Technosphere	Sweden
	Output	Emission	Acid H+	2.33E-02			g	Water	Sweden
	Output	Emission	Al	8.96E-04			g	Water	Sweden
	Output	Emission	Aluminium sulphate	2.31E-02			g	Water	Sweden
	Output	Emission	AOX as Cl-	7.27E-05			g	Water	Sweden
	Output	Emission	Aromatic HC	8.58E-05			g	Air	Sweden

	Output	Emission	Aromatic HC	9.45E-04			g	Water	Sweden
	Output	Emission	Arsenic	1.89E-06			g	Water	Sweden
	Output	Emission	As	1.12E-07			g	Air	Sweden
	Output	Emission	Assay Al2O3	1.32E-02			g	Water	Sweden
	Output	Emission	Ba	3.87E-04			g	Water	Sweden
	Output	Emission	Be	1.40E-09			g	Air	Sweden
	Output	Emission	Benzene	6.01E-05			g	Air	Sweden
	Output	Emission	BOD	5.93E-03			g	Water	Sweden
	Output	Emission	Cd	1.88E-06			g	Air	Sweden
	Output	Emission	Cd	3.57E-05			g	Water	Sweden
	Output	Emission	CH4	4.41E+02			g	Air	Sweden
	Output	Emission	Chlorinated CH	1.48E-07			g	Water	Sweden
	Output	Emission	Cl-	7.27E+00			g	Water	Sweden
	Output	Emission	CN-	5.04E-07			g	Water	Sweden
	Output	Emission	Co	1.40E-08			g	Water	Sweden
	Output	Emission	CO	1.63E+02			g	Air	Sweden
	Output	Emission	CO2	7.48E+04			g	Air	Sweden
	Output	Emission	COD	6.10E-01			g	Water	Sweden
	Output	Emission	Cr	4.69E-05			g	Water	Sweden
	Output	Emission	Cr	9.82E-08			g	Air	Sweden
	Output	Emission	Cu	3.93E-07			g	Air	Sweden
	Output	Emission	Cu	4.66E-06			g	Water	Sweden
	Output	Emission	Dimethyl-aminoacrylate	1.97E-03			g	Water	Sweden
	Output	Emission	Dioxin	1.40E-13			g	Water	Sweden
	Output	Emission	Dioxin	2.01E-14			g	Air	Sweden
	Output	Emission	Dissolved solids	4.97E-04			g	Water	Sweden
	Output	Emission	DOC	3.65E-05			g	Water	Sweden
	Output	Emission	Dust	2.35E+01			g	Air	Sweden
	Output	Emission	F-	6.10E-01			g	Water	Sweden
	Output	Emission	Fat	7.71E-03			g	Water	Sweden
	Output	Emission	Fe	5.88E-02			g	Water	Sweden
	Output	Emission	H2SO4	3.22E-02			g	Water	Sweden
	Output	Emission	Halogenated HC	8.33E-10			g	Air	Sweden
	Output	Emission	Halon H1301	6.02E-07			g	Air	Sweden
	Output	Emission	HC	1.38E-02			g	Water	Sweden
	Output	Emission	HCl	2.04E-2			g	Water	Sweden
	Output	Emission	HCl	6.90E-03			g	Air	Sweden
	Output	Emission	HF	6.06E-05			g	Air	Sweden
	Output	Emission	Hg	1.04E-08			g	Water	Sweden
	Output	Emission	Hg	4.85E-07			g	Air	Sweden
	Output	Emission	HNO3	8.07E-03			g	Water	Sweden
	Output	Emission	Inorganic salts and acids	4.19E+00			g	Water	Sweden
	Output	Emission	Metals	1.11E-03			g	Air	Sweden
	Output	Emission	Metals	5.14E-03			g	Water	Sweden
	Output	Emission	Mn	5.07E-07			g	Air	Sweden
	Output	Emission	N2O	6.54E+00			g	Air	Sweden
	Output	Emission	NaOH	4.34E-02			g	Water	Sweden
	Output	Emission	NH3	1.98E+00			g	Air	Sweden
	Output	Emission	NH4+	2.97E-03			g	Water	Sweden
	Output	Emission	Ni	4.52E-05			g	Air	Sweden
	Output	Emission	Ni	5.14E-04			g	Water	Sweden
	Output	Emission	Nitrogen organic bound	1.83E-05			g	Water	Sweden
	Output	Emission	NMVOC non-methane HC	3.06E+01			g	Air	Sweden
	Output	Emission	NO2	1.76E+02			g	Air	Sweden
	Output	Emission	NO3-	7.82E-04			g	Water	Sweden
	Output	Emission	NTA solution (100%)	3.88E-04			g	Water	Sweden
	Output	Emission	N-tot	8.37E-04			g	Water	Sweden
	Output	Emission	PAH policycl. Arom. HC	1.65E-06			g	Water	Sweden
	Output	Emission	PAH policycl. Arom. HC	6.46E-02			g	Air	Sweden
	Output	Emission	Pb	1.02E-05			g	Water	Sweden
	Output	Emission	Pb	7.14E-06			g	Air	Sweden
	Output	Emission	Phenol	7.47E-04			g	Water	Sweden
	Output	Emission	PO43-	6.05E-05			g	Water	Sweden
	Output	Emission	Potasium hydroxite (KOH)	4.56E-03			g	Water	Sweden
	Output	Emission	Radioactive emissions	2.55E-02			g	Water	Sweden

	Output	Emission	Radioactive emissions	2.77E+00			g	Air	Sweden
	Output	Emission	S2-	6.88E-05			g	Water	Sweden
	Output	Emission	Silicates	8.15E-03			g	Water	Sweden
	Output	Emission	SO2	1.20E+02			g	Air	Sweden
	Output	Emission	SO42-	5.50E-02			g	Water	Sweden
	Output	Emission	Sodium gluconate	1.12E-03			g	Water	Sweden
	Output	Emission	Sodium hypochlorite	1.12E-03			g	Water	Sweden
	Output	Emission	Sodium ions	4.08E-02			g	Water	Sweden
	Output	Emission	Sodium kapryl-aminodipropionate	2.23E-03			g	Water	Sweden
	Output	Emission	Suspended solids	2.48E+01			g	Water	Sweden
	Output	Emission	TEX (aliphatic)	5.56E-03			g	Water	Sweden
	Output	Emission	TOC	3.48E-03			g	Water	Sweden
	Output	Emission	Toluene	1.53E-05			g	Water	Sweden
	Output	Emission	Tridecylalkoholetoxilat	2.53E-03			g	Water	Sweden
	Output	Emission	Zn	1.21E-05			g	Air	Sweden
	Output	Emission	Zn	9.15E-04			g	Water	Sweden
	Output	Residue	Solid waste	1.17E+02			kg	Technosphere	Sweden
	Output	Residue	Waste water	1.73E-03			m3	Technosphere	Sweden

About Inventory	
Publication	Jonasson K., Environmental Aspects of the Use-Phase for Bearings in Trains. Environmental Systems Analysis, Report 2003:3, ISSN 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2003--3.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The goal of this LCA is to investigate the environmental impact of the use-phase for bearings in trains. Three generations of trains, so-called Electrical Multiple Units (EMUs), will be studied, and comparison will be made between processes within the life cycle of the bearings, and between the bearings in the different generations of EMUs.''
Detailed Purpose	Unknown
Commissioner	SKF Sverige AB - 415 50 Göteborg .
Practitioner	Karl Jonasson - .
Reviewer	Björn Andersson, - Environmental Systems Analysis, Chalmers University of Technology
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis. Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report, see 'Publication': ''SKF provides both bearings and bearing housings for trains, called axleboxes, which are mounted in direct connection with the train's wheels to make the wheel axle able to rotate (...). The bearings used for this purpose are in this study referred to as 'train bearings', even though there are other fields of application for bearings in trains (e.g. in the traction system). What type of rolling bearings used for the wheel axle varies according to performance needs and train design, but the function is essentially the same.''

SPINE LCI dataset: Wafer production, for photovoltaic cells. ESA-DBP

Administrative	
Finished	Y

Date Completed	2006
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Wafer production, for photovoltaic cells. ESA-DBP
Functional Unit	1 m2 of monocrystalline module
Functional Unit Explanation	The EG Si wafers are processed into solar cells and the cells are combined into monocrystalline modules. Due to wafer shaping 1.11m2 of wafer is needed per 1m2 module.
Process Type	Cradle to gate
Site	Not applicable
Sector	Materials and components
Owner	Not applicable
Technical system description	Production of EG Si (= electronic grade polycrystalline silicon) wafers: ''Figure 5 (page 12 in the report, see report link below) shows the principal steps in processing silicon to make wafers for cell production. As quartz is a common substance on earth and easy to mine, energy use in raw material extraction is assumed small and neglected from calculations. Metallurgical grade silicon (MG-Si) is produced from quartz (SiO2) in a large furnace. Coal is commonly used for reduction, a process that emits CO2. MG-Si is converted to trichlorosilane (SiHCl3) by the ''Siemens method'', which reacts with H2 in a large electric furnace producing electronic grade (EG-Si) polycrystalline silicon. No losses are mentioned for the Siemens process in the literature, which could be a false assumption. This is molten in a big pot, a crucible, in which a monocrystalline seed is planted. A monocrystal ingot grows around the seed and is slowly pulled out and cooled with a Czochralski (Cz) process. 28% material losses are assumed. The ingot is sliced into roughly 300 ¹m wafers with a multi-wire saw. Further 10% losses are assumed in wafer shaping.'' This process is included in the system described in ''Suomalainen K, 2006, Environmental life cycle assessment of a large-scale grid-connected PV power plant. Environmental Systems Analysis report 2006:14, Chalmers University of Technology, Gothenburg, Sweden'' at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2006--14.pdf

System Boundaries	
Nature Boundary	''As quartz is a common substance on earth and easy to mine, energy use in raw material extraction is assumed small and neglected from calculations.''
Time Boundary	Unknown. The importer of data to CPMDatabase makes a qualified guess that the average year of data is year 2000, based on the publication years of the literature references that are referred to in the report.
Geographical Boundary	The wafer production takes place in Spain, Europe. There is no comment on where raw material acquisition is done, however as stated in the report: ''As often site-specific information is unavailable, national or European statistics are used and accordingly stated.''
Other Boundaries	28% material losses are assumed in the Czochralski (Cz) process. 10% losses are assumed in wafer shaping.
Allocations	Not applicable.
Systems Expansions	Not applicable.

Flow Data	
General Activity QMetaData	
Date Conceived	Not applicable.
Data Type	Derived, mixed
Represents	Not applicable.

Method	Data is collected primarily from existing LCAs for raw material production, component manufacturers - environmental reports or correspondence via email - and project managers. As often site-specific information is unavailable, national or European statistics are used and accordingly stated.
Literature Reference	Suomalainen K, 2006, Environmental life cycle assessment of a large-scale grid-connected PV power plant. Environmental Systems Analysis report 2006:14, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_Report_2006--14.pdf
Notes	Geography: The wafer production takes place in Spain, Europe. There is no comment on where raw material acquisition is done, however as stated in the report: ''As often site-specific information is unavailable, national or European statistics are used and accordingly stated.''

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: the inventory data says 'Gas', it is not specified whether it is natural gas or gasoline	Input	Resource	*Gas	289			g	Ground	Not known
	Input	Resource	Baryte	52.4			g	Ground	
	Input	Resource	Bauxite	209			g	Ground	
	Input	Resource	Bentonite	45.7			g	Ground	
	Input	Resource	Chromium	48.6			g	Ground	
	Input	Resource	Clay	81.4			g	Ground	
	Input	Resource	Coal	1150			g	Ground	
	Input	Resource	Coal	31.2			MJ	Technosphere	
	Input	Resource	Copper	15.6			g	Ground	
	Input	Resource	Electricity	1010			MJ	Technosphere	Undefined
	Input	Resource	Gravel	3890			g	Ground	
	Input	Resource	Iron	820			g	Ground	
	Input	Resource	Lead	382			g	Ground	
	Input	Resource	Manganese	0.57			g	Ground	
	Input	Resource	Marl	952			g	Ground	
	Input	Resource	Nickel	39.1			g	Ground	
	Input	Resource	Sand	11600			g	Ground	
	Input	Resource	Silver	0.03			g	Ground	
	Input	Resource	Sodium chloride	11700			g	Ground	
	Input	Resource	Tin	0.02			g	Ground	
	Input	Resource	Water	1004000000			g	Water	Undefined
	Input	Resource	Zinc	0.04			g	Ground	
	Output	Emission	Acetaldehyde	0.07			g	Air	
	Output	Emission	Acetic acid	0.29			g	Air	
	Output	Emission	Acetone	0.07			g	Air	
	Output	Emission	Acetylene	0.01			g	Air	
	Output	Emission	Acids	281			g	Water	
	Output	Emission	Ag			0.01	g	Water	
	Output	Emission	Aldehydes			0.01	g	Air	
	Output	Emission	Aluminium	2.21			g	Air	
	Output	Emission	Aluminium	71.1			g	Water	
	Output	Emission	Ammonia	1.07			g	Water	
	Output	Emission	Arsenic, ion	0.14			g	Water	
	Output	Emission	As	0.01			g	Air	
	Output	Emission	Ba	0.04			g	Air	
	Output	Emission	Ba	6.74			g	Water	
	Output	Emission	Baryte	10.5			g	Water	
	Output	Emission	Be			0.01	g	Air	
	Output	Emission	Be			0.01	g	Water	
	Output	Emission	Benzene	0.06			g	Water	
	Output	Emission	Benzene	0.38			g	Air	
	Output	Emission	Benzo(a)pyrene			0.01	g	Air	
	Output	Emission	BOD	0.14			g	Water	
	Output	Emission	Boron, B	0.10			g	Water	
	Output	Emission	Boron, B	1.62			g	Air	
	Output	Emission	Bromine	0.17			g	Air	
	Output	Emission	Butane	1.04			g	Air	
	Output	Emission	Butene	0.03			g	Air	
	Output	Emission	Ca	117			g	Water	
	Output	Emission	Ca	2.55			g	Air	

	Output	Emission	Cd	0.01			g	Water	
	Output	Emission	CFC-11			0.01	g	Air	
	Output	Emission	CFC-114	0.02			g	Air	
	Output	Emission	CFC-12			0.01	g	Air	
	Output	Emission	CFC-13			0.01	g	Air	
	Output	Emission	Chromium	0.01			g	Air	
	Output	Emission	Chromium	0.71			g	Water	
	Output	Emission	Chromium VI			0.01	g	Water	
	Output	Emission	Cl-	1980			g	Water	
	Output	Emission	CO2	4220			g	Air	
	Output	Emission	Cobalt	0.02			g	Air	
	Output	Emission	Cobalt	0.14			g	Water	
	Output	Emission	Copper	0.06			g	Air	
	Output	Emission	Copper	0.35			g	Water	
	Output	Emission	Cyanide	0.01			g	Water	
	Output	Emission	Cyanide	0.03			g	Air	
	Output	Emission	Dichloromethane	0.01			g	Water	
	Output	Emission	Ethane	1.69			g	Air	
	Output	Emission	Ethanol	0.13			g	Air	
	Output	Emission	Ethene	0.78			g	Air	
	Output	Emission	Ethylbenzene	0.20			g	Air	
	Output	Emission	F-	69.4			g	Water	
	Output	Emission	Formaldehyde	0.45			g	Air	
	Output	Emission	H2S	2.22			g	Air	
	Output	Emission	Halon-1301			0.01	g	Air	
	Output	Emission	HCFC-22			0.01	g	Air	
	Output	Emission	HCl	28.1			g	Air	
	Output	Emission	Helium, He	0.64			g	Air	
	Output	Emission	Heptane	0.17			g	Air	
	Output	Emission	Hexane	0.35			g	Air	
	Output	Emission	HF	5.19			g	Air	
	Output	Emission	Hg			0.01	g	Water	
	Output	Emission	Hydrocarbons	0.07			g	Water	
	Output	Emission	Hydrocarbons	0.85			g	Air	
	Output	Emission	Hydrocarbons	31.5			g	Water	
	Output	Emission	Hydrocarbons, aromatic	0.03			g	Air	
	Output	Emission	Hydrocarbons, aromatic	0.29			g	Water	
	Output	Emission	Hydroxide, OH-	10.3			g	Water	
	Output	Emission	Iron	1.55			g	Air	
	Output	Emission	Iron	89.5			g	Water	
	Output	Emission	Lead	0.42			g	Water	
	Output	Emission	Manganese	1.64			g	Water	
	Output	Emission	Methanol	0.14			g	Air	
	Output	Emission	Mg	0.05			g	Air	
	Output	Emission	Mg	58.2			g	Water	
	Output	Emission	Mo	0.01			g	Air	
	Output	Emission	Mo	0.24			g	Water	
	Output	Emission	N	2.17			g	Air	
	Output	Emission	N2O	1.03			g	Air	
	Output	Emission	Na	238			g	Water	
	Output	Emission	Ni	0.16			g	Air	
	Output	Emission	Ni	0.35			g	Water	
	Output	Emission	Nitrate	89.5			g	Water	
	Output	Emission	Nitrite	0.11			g	Water	
	Output	Emission	P Total	0.03			g	Air	
	Output	Emission	PAH	0.01			g	Water	
	Output	Emission	Particles	118			g	Air	
	Output	Emission	Pentane	1.36			g	Air	
	Output	Emission	Phenol			0.01	g	Air	
	Output	Emission	Phenols	0.07			g	Water	
	Output	Emission	Phosphorus compounds			0.01	g	Water	
	Output	Emission	Propane	1.23			g	Air	
	Output	Emission	Salts	151			g	Water	

	Output	Emission	Sb			0.01	g	Water	
	Output	Emission	Sb			0.01	g	Air	
	Output	Emission	Se	0.02			g	Air	
	Output	Emission	Se	0.36			g	Water	
	Output	Emission	Silicon, Si	0.02			g	Water	
	Output	Emission	Silicon, Si	7.95			g	Air	
	Output	Emission	Solved substances	29.4			g	Water	
	Output	Emission	Strontium, Sr	3.65			g	Water	
	Output	Emission	Sulfate	634			g	Water	
	Output	Emission	Sulfide	0.02			g	Water	
	Output	Emission	Sulfur trioxide	0.17			g	Water	
	Output	Emission	Suspended substances	1.23			g	Water	
	Output	Emission	Tetrachloroethene			0.01	g	Water	
	Output	Emission	Tetrachloromethane			0.01	g	Water	
	Output	Emission	Ti	4.17			g	Water	
	Output	Emission	Tin			0.01	g	Water	
	Output	Emission	Tl			0.01	g	Air	
	Output	Emission	TOC	14.1			g	Water	
	Output	Emission	Toluene	0.05			g	Water	
	Output	Emission	Toluene	0.27			g	Air	
	Output	Emission	Trichloroethene	0.01			g	Water	
	Output	Emission	Undissolved substances	40.0			g	Water	
	Output	Emission	V	0.37			g	Water	
	Output	Emission	V	0.51			g	Air	
	Output	Emission	VOC	0.16			g	Water	
	Output	Emission	Zinc	0.76			g	Water	
	Output	Emission	Zn	0.12			g	Air	
Notes: This value is calculated from other values in the literature reference, by the importer of data. For every Substance the total weight for the whole 62 MW PV installation is given in kg. The total wafer area for the whole installation is also given. By multiplying the weight of substance per m2 module with the total area of wafer per installation and then dividing this with the total weight of substance per installation the value 1.11 m2 wafer per m2 module area is given.	Output	Product	wafer	1.11			m2	Technosphere	

About Inventory	
Publication	Suomalainen K, 2006, Environmental life cycle assessment of a large-scale grid-connected PV power plant. Environmental Systems Analysis report 2006:14, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2006--14.pdf
Intended User	LCA practitioners
General Purpose	Master Thesis Report
Detailed Purpose	''Concern for the environment and the threat of uncontrollable catastrophes has caused people around the world to reconsider their daily choices. Individuals, communities and governments are taking actions against global warming; be it choosing a bike over a car, investing in hydrogen buses or building the world's largest solar photovoltaic power plant.'' This thesis presents a systematically performed life cycle assessment of that power plant, and explores the environmental impacts of scaling up the use of this technology. Consistent with the EU directive on renewable electricity (2001/77/CE) Portugal has the aim to deliver 39 percent (including large hydro) of its gross electricity consumption in 2010 from renewable energy sources. In 2003 the government defined a new energy policy framework in

	which one of the three main strategic points is to promote sustainable development by supporting the development of renewable energy resources and improving energy efficiency, in order to meet the Kyoto Protocol commitment. Two of the most ambitious targets for 2010 regard generation of wind power, increasing from the currently installed capacity of 900 MW to 3750 MW, and photovoltaics, increasing from 2 MWp to 150 MWp.
Commissioner	Not applicable - .
Practitioner	Kiti Suomalainen - .
Reviewer	Unknown -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	''For data on emissions from processes, an earlier life cycle inventory on monocrystalline silicon wafer production is used. This data includes a total aggregated inventory for the production of wafers; raw materials, primary energy requirements as well as emissions to air, water and soil are given per wafer. In this study only the emissions from processes are used i.e. emissions from electricity use are calculated separately and subtracted from this data. The CO2 emissions from the reduction in metallurgical grade silicon production is calculated as two carbon atoms per one silicon atom. Also the amount of coal used in this process is calculated by the same principle.'' ''Energy data is retrieved from existing studies and shown in the flowchart under 'Function' for the various steps. Reduction of SiO2 to MG-Si takes 12 kWhe/kgSiMG. For the Siemens process 83 kWhe/kgSiEG is used. For ingot growth 40 kWhe/kgSiCz is assumed and wafer slicing is assumed to require 19 kWhe/m2 wafer.'' ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Importer of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable

SPINE LCI dataset: Waste collection vehicle, diesel driven. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Waste collection vehicle, diesel driven. ESA-DBP
Functional Unit	one metric ton of collected waste
Functional Unit Explanation	Collecting and transporting one ton of waste in Gothenburg city.
Process Type	Cradle to grave
Site	Gothenburg, Sweden
Sector	Sector
Owner	Gothenburg, Sweden
Technical system description	Excerpts from the report (for report see link below): ''2.2.1 Options Three types of waste collection vehicles were compared:

	· A diesel waste collection vehicle · A gas waste collection vehicle · A gas-electric hybrid waste collection vehicle (..) The vehicles are back-loading waste collection vehicles, used mainly for collection of municipal waste. The gas and diesel vehicles use the combustion engines both when they run and when they load waste (...) The vehicles consist of a truck chassis from Volvo AB, model FL6E, and a waste collection unit, i.e. the container and waste loading equipment on the truck, from Norba AB, model RL 200L.'' ''When a waste collection vehicle stops to collect waste, the combustion engine is kept running and is used to lift the waste into the truck and to compact it. This also means that the vehicle idles for a considerable amount of time when the workers collect waste bins, emitting pollutants without doing any work. The collection is often also considered noisy by people in the vicinity. According to measurements at Renova, the time a waste collection vehicle stands still accounts for about 60 percent of the total working time when operating in the central parts of Gothenburg (Österman, 2002). In 2002, Renova, together with Volvo AB, Norba AB and ETP AB, started to develop a vehicle that uses natural gas when running, but automatically turns the combustion engine off when it has stopped and uses electricity to load and compact the waste. Using this technique reduces air emissions and noise in the vicinity of the collection sites.'' Figure 5 in the report shows a flow chart of the life cycle of the vehicles. Some facts about the diesel (and gas) vehicle (Table 1 in the report): Truck model: Volvo FL6E Waste collection unit model: Norba RL 200L Manufacturing year: 2001 Service Weight: 10 720 kg Loading capacity: 7 280 kg Engine power: 162 kW Emissions control: Catalytic converter and CRT particle filter This process is included in the system described in Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries	
Nature Boundary	Excerpt from the report (for report see 'Publication'): ''The LCA covers all of the life cycle of the waste collection vehicles from the cradle, when raw materials are extracted, to the grave, end-of-life treatment of the used vehicle.''
Time Boundary	Excerpt from the report (for report see 'Publication'): ''The assessment focuses on the technical system of today with a few years' perspective; data from the recent years were used, and the lifetime of a vehicle was assumed to be ten years.'' NB: The report is written in 2004 and 2005.
Geographical Boundary	The study is limited to waste collection in central Gothenburg, Sweden.
Other Boundaries	Excerpts from the report (for report see 'Publication'): ''The LCA covers all of the life cycle of the waste collection vehicles from the cradle, when raw materials are extracted, to the grave, end-of-life treatment of the used vehicle. Maintenance and repair was also accounted for. Concerning the end-of-life treatment, sorting into different material fractions was included whereas re-melting to produce another product was allocated to the new product, thus not accounted for.'' NB: The waste treatment (e.g. burning) of the collected waste was not included in the life cycle of the waste collection vehicle. ''Environmental impacts from the manufacturing of capital goods, such as machines used in the manufacturing of the vehicles, were not considered, nor were impacts from

	activities of employees.'' ''The study is limited to waste collection in central Gothenburg, using a Volvo chassis of model FL6E with a Norba waste collection unit of model RL 200L. The gas vehicles were assumed to use natural gas (not biogas). Environmental impacts from noise or odour were not considered.''
Allocations	Excerpts from the report (for report see 'Publication'): ''Concerning the end-of-life treatment, sorting into different material fractions was included whereas re-melting to produce another product was allocated to the new product, thus not accounted for.'' ''Allocations in material production were mainly based on weight and in vehicle manufacturing processes, on number of products.'' ''Most of the disassembled parts are transported to the fragmentation facility at Stena fragmentering AB in Halmstad, Sweden. The facility treats a wide variety of scraps, of which about one third is vehicle scrap (Stena fragmentering AB, 2005). Stena fragmentises and sorts the scrap into separate material fractions. Allocation of environmental impacts was based on weight of the unsorted scrap input to the facility. The amount of sorted scrap from a vehicle out from the fragmentation facility was calculated from the total amount of metals in the vehicle and multiplying this by the degree of recycling. The total amount of sorted scrap from the facility was 137 930 tons. The total amount of the residuals including metals that could not be sorted out was 52 928 tons (Stena fragmentering AB, 2005) and the metal fraction in the residuals was 8% (Eskilsson, 2002). This gave the degree of recycling for metals: 137 930 / (137 930+52 928·0.08) = 97%''
Systems Expansions	Excerpt from the report (for report see 'Publication'): ''A few system expansions were used to account for excess energy produced in some processes.''

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, mixed
Represents	See 'Function'.
Method	Excerpt from the report: ''2.3.2 Data collection From the use phase, data from direct measurements carried out at Renova of the studied vehicles were available. Also for the maintenance and repair, data from Renova were used. Data concerning production and end-of-life treatment were collected by personal communication, from annual environmental reports and from previous life cycle assessment reports. The main calculations were carried out in the LCA software LCAiT (CIT Ekologik, 2003), where some general data also were included.'' NB: Chapter 2.3.2 is a chapter in the report. The reference (CIT Ekologik, 2003) can be found in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	The flow table here is a shortened version of the flow table in the report. All values for resources above 0.01 kg and for emissions above 0.001 kg is in this table. All values with the unit Bq is excluded.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Acetylene	0.0000256			m3	Technosphere	
	Input	Refined resource	Steel scrap	-0.184			kg	Technosphere	
	Input	Resource	Bauxite	0.0415			kg	Ground	
	Input	Resource	Coal	0.122			kg	Ground	
	Input	Resource	Crude oil	3.55			kg	Ground	
	Input	Resource	Hard coal	0.084			kg	Ground	
	Input	Resource	Iron ore	0.522			kg	Ground	
	Input	Resource	Latex rubber	0.0729			kg	Ground	
	Input	Resource	Lignite	0.1			kg	Ground	
	Input	Resource	Limestone	0.0356			kg	Ground	
	Input	Resource	Natural gas	0.171			kg	Ground	
	Input	Resource	Olivine	0.0107			kg	Ground	
	Input	Resource	Water	4.83			kg	Ground	
	Output	Emission	Cl-	0.0313			kg	Water	
	Output	Emission	CO	0.0415			kg	Air	Sweden

	Output	Emission	CO2	11.6			kg	Air	
	Output	Emission	COD	0.00103			kg	Water	
	Output	Emission	Hydrocarbons	0.0893			kg	Air	
	Output	Emission	Methane	0.00161			kg	Air	
	Output	Emission	Na+	0.008			kg	Water	
	Output	Emission	NMVOC	0.00528			kg	Air	
	Output	Emission	NOx	0.141			kg	Air	
	Output	Emission	SO2	0.00164			kg	Air	
	Output	Emission	SO42-	0.0133			kg	Water	
	Output	Emission	SOx	0.00328			kg	Air	
	Output	Emission	VOC	0.00148			kg	Air	
Notes: To landfill.	Output	Residue	Concentration sand	0.387			kg	Technosphere	
Notes: To landfill.	Output	Residue	Granite	0.294			kg	Technosphere	
Notes: Treated.	Output	Residue	Hazardous waste	0.00392			kg	Technosphere	
	Output	Residue	Hazardous waste	0.071			kg	Technosphere	
	Output	Residue	Household waste	0.0216			kg	Technosphere	
	Output	Residue	Inert residues	0.384			kg	Technosphere	
	Output	Residue	Landfill waste	0.143			kg	Technosphere	
Notes: To landfill.	Output	Residue	Margin ore waste	0.0499			kg	Technosphere	
	Output	Residue	Metal scrap	0.00528			kg	Technosphere	
	Output	Residue	Mineral waste	0.00241			kg	Technosphere	
	Output	Residue	Non magnetic waste	0.00378			kg	Technosphere	
	Output	Residue	Ore dressing residue	0.059			kg	Technosphere	
	Output	Residue	Plastics	0.00663			kg	Technosphere	
	Output	Residue	Plastics and electrolyte in lead battery	0.00325			kg	Technosphere	
	Output	Residue	Red mud	0.00129			kg	Technosphere	
	Output	Residue	Rubber	0.00514			kg	Technosphere	
	Output	Residue	Rubber tire	0.138			kg	Technosphere	
Notes: LD-slag (Linz-Donawitz)	Output	Residue	Slag	0.00644			kg	Technosphere	
	Output	Residue	Slag	0.159			kg	Technosphere	
	Output	Residue	Slags and ashes	0.00157			kg	Technosphere	
Notes: LD-sludge (Linz-Donawitz)	Output	Residue	Sludge	0.00506			kg	Technosphere	
	Output	Residue	Sludge	0.00799			kg	Technosphere	
	Output	Residue	Solid waste	0.0338			kg	Technosphere	
	Output	Residue	To incinerator	0.00387			kg	Technosphere	
	Output	Residue	Treated waste	0.0124			kg	Technosphere	
	Output	Residue	Unspecified waste	0.268			kg	Technosphere	
	Output	Residue	Waste deposit	0.0121			kg	Technosphere	

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	Renova AB and LCA practitioners
General Purpose	Excerpt from the report (for report see Publication): ''The waste and recycling company Renova AB has developed a new type of waste collection vehicle, which has been used and evaluated for waste collection in central Gothenburg for a few years. What distinguishes this type of vehicle from conventional waste collection vehicles is, firstly, that it uses natural gas to drive instead of diesel, and secondly, that it turns the combustion engine off at the collection stops and uses electric power to load and compact waste. In this master's thesis the environmental performance of such a gas-electric hybrid waste collection vehicle was evaluated in comparison with a conventional diesel vehicle and a natural gas vehicle without the hybrid technique.''
Detailed Purpose	Excerpt from the report (for report see 'Publication'): ''The goal of this LCA study was to evaluate the environmental impact from a waste collection vehicle running on natural gas and loading waste by using electricity when used in the central parts of Gothenburg.(...) The purpose of the study was to use the results as a platform for decisions of future waste collection within Renova AB - if hybrid vehicles should be used and what is most important to improve for minimisation of the environmental impact. The intended audience of the report is mainly personnel at Renova but also some suppliers are interested in the results.''
Commissioner	Renova AB & Chalmers University of Technology - .

Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	Excerpts from the report (for report see 'Publication'): ''Renova uses the electric hybrid vehicles to collect waste in central Gothenburg and transport it to their waste incineration plant in Sävenäs (in Gothenburg). Specific measurements of emissions and energy use from this area were used. Electricity used in the hybrid vehicle was assumed to originate from average Swedish electricity production. In the production of the vehicle, both specific and general average data were used; see further in sections 3.1 and 3.2.'' ''Many parts, which often are replaced, are available at Renova's storage and these were weighed and the material contents were assessed by visual inspection and estimation. Missing parts with the same function as available ones were assumed to be similar to the available ones. Other parts were assessed in a discussion with Bengt Svensson at the workshop. Starter batteries were estimated to weigh 20 kg and the same material data were used as for the batteries in the electric hybrid equipment. In the work orders, tires are not included, but according to Jan Örn at the workshop (personal communication) they are usually replaced once every year. A set of tires weighs 370 kg according to Robert Svensson at Volvo (personal communication). The total materials used in maintenance and repair corresponding to a vehicle life cycle, not including extra material for hybrid equipment, are shown in Table 17. For the production of these materials the same general data were used as in the production phase of the vehicle (see section 3.1.1). ''Other chemicals'' are mainly windscreenwasher fluid and antifreeze and they have not been traced back to the cradle. Table 17. Materials used in maintenance and repair. Material Weight [kg] Steel 1150 Aluminium 95 Copper 0.86 Plastics 163 Rubber (mainly tires) 3390 Glass 22.7 Paper 2.7 Lead batteries 106 Oil 1130 Other chemicals 535 litres The batteries in the electric hybrid can be charged about 1000 times (Österman, 2002), which is not enough for the entire life of the vehicle. In this study it was assumed that the batteries will be replaced twice during a lifetime of ten years. Calculations for the extra repair needed on hybrid vehicles are based on the production and waste of two extra sets of batteries. The waste generated during maintenance and repair was estimated from the materials consumed. The amounts of scrap was estimated by using the same degree of recycling of metals as in the end-of-life treatment of the vehicle at Stena fragmentering, 97% (compare section 3.5). The metal fractions not recycled were assumed to be landfilled. Oil and other chemicals were presented as hazardous waste. The same amounts as used of tires, plastics, paper and glass respectively, were presented as waste of those materials. No further analysis of the waste was carried out, except for batteries (both starter batteries and hybrid equipment batteries), which are transported to Boliden Bergsöe in Landskrona, Sweden, as in section 3.5.'' ''Most of the disassembled parts are transported to the fragmentation facility at Stena fragmentering AB in Halmstad, Sweden. The facility treats a wide variety of scraps, of which about one third is vehicle scrap (Stena fragmentering AB, 2005). Stena fragmentises and sorts the scrap into separate material fractions. Allocation of environmental impacts was based on weight of the unsorted scrap input to the facility. The amount of sorted scrap from a vehicle out from the fragmentation facility was calculated from the total amount of metals in the vehicle and multiplying this by the degree of recycling. The total amount of sorted scrap from the facility was 137 930 tons. The total amount of the residuals including metals that could not be sorted out was 52 928 tons (Stena fragmentering AB, 2005) and the metal fraction in the residuals was 8% (Eskilsson, 2002). This gave the degree of recycling for metals: 137 930 / (137 930 + 52 928·0.08) = 97%'' ''The transportation to Stena fragmentering was assumed to be accomplished by truck and the distance from Gothenburg to Halmstad is 145 km. The recycling processes of the fragmentised scrap metals were allocated to material production for a future product, i.e. not included in this study. The batteries are sent from Gothenburg to Boliden Bergsöe in Landskrona, Sweden for lead recycling. It was assumed to be transported by truck, 244 km. The lead scrap from the batteries is presented as a negative input and the other materials in the batteries are presented as waste, but the recycling process was not included since it was allocated to production of new lead. For the rest of the hybrid electric equipment, waste is given according to the materials it consists of, with a 97% degree of recycling for metals (assumed to be the same as for the vehicle scrapping at Stena fragmentering). The residual metals were assumed to go to landfill, chemicals are presented as hazardous waste, and the rest of the materials used are presented as waste of the same materials.

	The waste was not further analysed.'' ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Waste collection vehicle, driven by compressed natural gas. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Waste collection vehicle, driven by compressed natural gas. ESA-DBP
Functional Unit	one metric ton of collected waste
Functional Unit Explanation	Collecting and transporting one ton of waste in Gothenburg city.
Process Type	Cradle to grave
Site	Gothenburg, Sweden
Sector	Sector
Owner	Gothenburg, Sweden
Technical system description	Excerpt from the report (for report see link below): ''2.2.1 Options Three types of waste collection vehicles were compared: · A diesel waste collection vehicle · A gas waste collection vehicle · A gas-electric hybrid waste collection vehicle (..) The vehicles are back-loading waste collection vehicles, used mainly for collection of municipal waste. The gas and diesel vehicles use the combustion engines both when they run and when they load waste (...) The vehicles consist of a truck chassis from Volvo AB, model FL6E, and a waste collection unit, i.e. the container and waste loading equipment on the truck, from Norba AB, model RL 200L.'' ''When a waste collection vehicle stops to collect waste, the combustion engine is kept running and is used to lift the waste into the truck and to compact it. This also means that the vehicle idles for a considerable amount of time when the workers collect waste bins, emitting pollutants without doing any work. The collection is often also considered noisy by people in the vicinity. According to measurements at Renova, the time a waste collection vehicle stands still accounts for about 60 percent of the total working time when operating in the central parts of Gothenburg (Österman, 2002). In 2002, Renova, together with Volvo AB, Norba AB and ETP AB, started to develop a vehicle that uses natural gas when running, but automatically turns the combustion engine off when it has stopped and uses electricity to load and compact the waste. Using this technique reduces air emissions and noise in the vicinity of the collection sites.'' Figure 5 in the report shows a flow chart of the life cycle of the vehicles.

	Some facts about the diesel (and gas) vehicle (Table 1 in the report): Truck model: Volvo FL6E Waste collection unit model: Norba RL 200L Manufacturing year: 2001 Service Weight: 10 720 kg Loading capacity: 7 280 kg Engine power: 162 kW Emissions control: Catalytic converter and CRT particle filter This process is included in the system described in Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report (for report see 'Publication'): ''The LCA covers all of the life cycle of the waste collection vehicles from the cradle, when raw materials are extracted, to the grave, end-of-life treatment of the used vehicle.''
Time Boundary	Excerpt from the report (for report see 'Publication'): ''The assessment focuses on the technical system of today with a few years' perspective; data from the recent years were used, and the lifetime of a vehicle was assumed to be ten years.'' NB: The report is written in 2004 and 2005.
Geographical Boundary	The study is limited to waste collection in central Gothenburg, Sweden.
Other Boundaries	Excerpts from the report (for report see 'Publication'): ''The LCA covers all of the life cycle of the waste collection vehicles from the cradle, when raw materials are extracted, to the grave, end-of-life treatment of the used vehicle. Maintenance and repair was also accounted for. Concerning the end-of-life treatment, sorting into different material fractions was included whereas re-melting to produce another product was allocated to the new product, thus not accounted for.'' NB: The waste treatment (e.g. burning) of the collected waste was not included in the life cycle of the waste collection vehicle. ''Environmental impacts from the manufacturing of capital goods, such as machines used in the manufacturing of the vehicles, were not considered, nor were impacts from activities of employees.'' ''The study is limited to waste collection in central Gothenburg, using a Volvo chassis of model FL6E with a Norba waste collection unit of model RL 200L. The gas vehicles were assumed to use natural gas (not biogas). Environmental impacts from noise or odour were not considered.''

Allocations	Excerpts from the report (for report see 'Publication'): ''Concerning the end-of-life treatment, sorting into different material fractions was included whereas re-melting to produce another product was allocated to the new product, thus not accounted for.'' ''Allocations in material production were mainly based on weight and in vehicle manufacturing processes, on number of products.'' ''Most of the disassembled parts are transported to the fragmentation facility at Stena fragmentering AB in Halmstad, Sweden. The facility treats a wide variety of scraps, of which about one third is vehicle scrap (Stena fragmentering AB, 2005). Stena fragmentises and sorts the scrap into separate material fractions. Allocation of environmental impacts was based on weight of the unsorted scrap input to the facility. The amount of sorted scrap from a vehicle out from the fragmentation facility was calculated from the total amount of metals in the vehicle and multiplying this by the degree of recycling. The total amount of sorted scrap from the facility was 137 930 tons. The total amount of the residuals including metals that could not be sorted out was 52 928 tons (Stena fragmentering AB, 2005) and the metal fraction in the residuals was 8% (Eskilsson, 2002). This gave the degree of recycling for metals: 137 930 / (137 930+52 928·0.08) = 97%''
Systems Expansions	Excerpt from the report (for report see 'Publication'): ''A few system expansions were used to account for excess energy produced in some processes.''

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, mixed
Represents	See 'Function'.
Method	Excerpt from the report: ''2.3.2 Data collection From the use phase, data from direct measurements carried out at Renova of the studied vehicles were available. Also for the maintenance and repair, data from Renova were used. Data concerning production and end-of-life treatment were collected by personal communication, from annual environmental reports and from previous life cycle assessment reports. The main calculations were carried out in the LCA software LCAiT (CIT Ekologik, 2003), where some general data also were included.'' NB: Chapter 2.3.2 is a chapter in the report. The reference (CIT Ekologik, 2003) can be found in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	The flow table here is a shortened version of the flow table in the report. All values for resources above 0.01 kg and for emissions above 0.001 kg is in this table. All values with the unit Bq is excluded.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Steel scrap	-0.184			kg	Technosphere	
	Input	Resource	Bauxite	0.0415			kg	Ground	
	Input	Resource	Coal	0.122			kg	Ground	
	Input	Resource	Crude oil	0.304			kg	Ground	
	Input	Resource	Hard coal	0.084			kg	Ground	
	Input	Resource	Iron ore	0.528			kg	Ground	
	Input	Resource	Latex rubber	0.0729			kg	Ground	
	Input	Resource	Lignite	0.1			kg	Ground	
	Input	Resource	Limestone	0.0356			kg	Ground	
	Input	Resource	Natural gas	5.27			kg	Ground	
	Input	Resource	Olivine	0.0107			kg	Ground	
	Input	Resource	Water	4.83			kg	Ground	
	Output	Emission	Cl-	0.0313			kg	Water	
	Output	Emission	CO	0.0215			kg	Air	
	Output	Emission	CO2	15.9			kg	Air	
	Output	Emission	COD	0.00103			kg	Water	
	Output	Emission	Hydrocarbons	0.00589			kg	Air	
	Output	Emission	Methane	0.0204			kg	Air	
	Output	Emission	Na+	0.008			kg	Water	
	Output	Emission	NMVOC	0.00105			kg	Air	
	Output	Emission	NOx	0.0398			kg	Air	

	Output	Emission	Particles	0.001			kg	Air	
	Output	Emission	SO2	0.00164			kg	Air	
	Output	Emission	SO42-	0.0133			kg	Water	
	Output	Emission	VOC	0.00148			kg	Air	
Notes: To landfill.	Output	Residue	Concentration sand	0.387			kg	Technosphere	
	Output	Residue	Dust	0.00366			kg	Technosphere	
	Output	Residue	Granite	0.294			kg	Technosphere	
Notes: Treated.	Output	Residue	Hazardous waste	0.00392			kg	Technosphere	
	Output	Residue	Hazardous waste	0.071			kg	Technosphere	
	Output	Residue	Household waste	0.0216			kg	Technosphere	
	Output	Residue	Inert residues	0.384			kg	Technosphere	
	Output	Residue	Landfill waste	0.143			kg	Technosphere	
Notes: To landfill.	Output	Residue	Margin ore waste	0.0449			kg	Technosphere	
	Output	Residue	Metal scrap	0.00528			kg	Technosphere	
	Output	Residue	Mineral waste	0.00241			kg	Technosphere	
	Output	Residue	Non magnetic waste	0.00378			kg	Technosphere	
	Output	Residue	Ore dressing residue	0.059			kg	Technosphere	
	Output	Residue	Plastics	0.00663			kg	Technosphere	
	Output	Residue	Plastics and electrolyte in lead battery	0.00325			kg	Technosphere	
	Output	Residue	Red mud	0.00129			kg	Technosphere	
	Output	Residue	Rubber	0.00514			kg	Technosphere	
	Output	Residue	Rubber tire	0.138			kg	Technosphere	
Notes: LD-slag (Linz-Donawitz)	Output	Residue	Slag	0.00644			kg	Technosphere	
	Output	Residue	Slag	0.159			kg	Technosphere	
	Output	Residue	Slags and ashes	0.00157			kg	Technosphere	
Notes: LD-sludge (Linz-Donawitz)	Output	Residue	Sludge	0.00506			kg	Technosphere	
	Output	Residue	Sludge	0.00799			kg	Technosphere	
	Output	Residue	Solid waste	0.0338			kg	Technosphere	
	Output	Residue	To incinerator	0.00387			kg	Technosphere	
	Output	Residue	Treated waste	0.0124			kg	Technosphere	
	Output	Residue	Unspecified waste	0.273			kg	Technosphere	
	Output	Residue	Waste deposit	0.0121			kg	Technosphere	

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	Renova AB and LCA practitioners
General Purpose	Excerpt from the report (for report see 'Publication'): ''The waste and recycling company Renova AB has developed a new type of waste collection vehicle, which has been used and evaluated for waste collection in central Gothenburg for a few years. What distinguishes this type of vehicle from conventional waste collection vehicles is, firstly, that it uses natural gas to drive instead of diesel, and secondly, that it turns the combustion engine off at the collection stops and uses electric power to load and compact waste. In this master's thesis the environmental performance of such a gas-electric hybrid waste collection vehicle was evaluated in comparison with a conventional diesel vehicle and a natural gas vehicle without the hybrid technique.''
Detailed Purpose	Excerpt from the report (for report see 'Publication'): ''The goal of this LCA study was to evaluate the environmental impact from a waste collection vehicle running on natural gas and loading waste by using electricity when used in the central parts of Gothenburg.(...) The purpose of the study was to use the results as a platform for decisions of future waste collection within Renova AB - if hybrid vehicles should be used and what is most important to improve for minimisation of the environmental impact. The intended audience of the report is mainly personnel at Renova but also some suppliers are interested in the results.''
Commissioner	Renova AB & Chalmers University of Technology - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.

About Data	Excerpts from the report (for report see 'Publication'): ''Renova uses the electric hybrid vehicles to collect waste in central Gothenburg and transport it to their waste incineration plant in Sävenäs (in Gothenburg). Specific measurements of emissions and energy use from this area were used. Electricity used in the hybrid vehicle was assumed to originate from average Swedish electricity production. In the production of the vehicle, both specific and general average data were used; see further in sections 3.1 and 3.2.'' ''Many parts, which often are replaced, are available at Renova's storage and these were weighed and the material contents were assessed by visual inspection and estimation. Missing parts with the same function as available ones were assumed to be similar to the available ones. Other parts were assessed in a discussion with Bengt Svensson at the workshop. Starter batteries were estimated to weigh 20 kg and the same material data were used as for the batteries in the electric hybrid equipment. In the work orders, tires are not included, but according to Jan Örn at the workshop (personal communication) they are usually replaced once every year. A set of tires weighs 370 kg according to Robert Svensson at Volvo (personal communication). The total materials used in maintenance and repair corresponding to a vehicle life cycle, not including extra material for hybrid equipment, are shown in Table 17. For the production of these materials the same general data were used as in the production phase of the vehicle (see section 3.1.1). ''Other chemicals'' are mainly windscreenwasher fluid and antifreeze and they have not been traced back to the cradle. Table 17. Materials used in maintenance and repair. Material Weight [kg] Steel 1150 Aluminium 95 Copper 0.86 Plastics 163 Rubber (mainly tires) 3390 Glass 22.7 Paper 2.7 Lead batteries 106 Oil 1130 Other chemicals 535 litres The batteries in the electric hybrid can be charged about 1000 times (Österman, 2002), which is not enough for the entire life of the vehicle. In this study it was assumed that the batteries will be replaced twice during a lifetime of ten years. Calculations for the extra repair needed on hybrid vehicles are based on the production and waste of two extra sets of batteries. The waste generated during maintenance and repair was estimated from the materials consumed. The amounts of scrap was estimated by using the same degree of recycling of metals as in the end-of-life treatment of the vehicle at Stena fragmentering, 97% (compare section 3.5). The metal fractions not recycled were assumed to be landfilled. Oil and other chemicals were presented as hazardous waste. The same amounts as used of tires, plastics, paper and glass respectively, were presented as waste of those materials. No further analysis of the waste was carried out, except for batteries (both starter batteries and hybrid equipment batteries), which are transported to Boliden Bergsöe in Landskrona, Sweden, as in section 3.5.'' ''Most of the disassembled parts are transported to the fragmentation facility at Stena fragmentering AB in Halmstad, Sweden. The facility treats a wide variety of scraps, of which about one third is vehicle scrap (Stena fragmentering AB, 2005). Stena fragmentises and sorts the scrap into separate material fractions. Allocation of environmental impacts was based on weight of the unsorted scrap input to the facility. The amount of sorted scrap from a vehicle out from the fragmentation facility was calculated from the total amount of metals in the vehicle and multiplying this by the degree of recycling. The total amount of sorted scrap from the facility was 137 930 tons. The total amount of the residuals including metals that could not be sorted out was 52 928 tons (Stena fragmentering AB, 2005) and the metal fraction in the residuals was 8% (Eskilsson, 2002). This gave the degree of recycling for metals: 137 930 / (137 930 + 52 928·0.08) = 97%'' ''The transportation to Stena fragmentering was assumed to be accomplished by truck and the distance from Gothenburg to Halmstad is 145 km. The recycling processes of the fragmentised scrap metals were allocated to material production for a future product, i.e. not included in this study. The batteries are sent from Gothenburg to Boliden Bergsöe in Landskrona, Sweden for lead recycling. It was assumed to be transported by truck, 244 km. The lead scrap from the batteries is presented as a negative input and the other materials in the batteries are presented as waste, but the recycling process was not included since it was allocated to production of new lead. For the rest of the hybrid electric equipment, waste is given according to the materials it consists of, with a 97% degree of recycling for metals (assumed to be the same as for the vehicle scrapping at Stena fragmentering). The residual metals were assumed to go to landfill, chemicals are presented as hazardous waste, and the rest of the materials used are presented as waste of the same materials. The waste was not further analysed.'' ____ ESA Database Project. Years: 2009-2011.

	Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report (for report see 'Publication'): ''The conventional gas vehicle and the hybrid vehicle use compressed natural gas as fuel. When the terms ''gas vehicle'' or ''gas engine'' are used in this report they refer to a vehicle running on natural gas (and should not be confused with petrol).

SPINE LCI dataset: Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Waste collection vehicle, driven by electricity and compressed natural gas. ESA-DBP
Functional Unit	one metric ton of collected waste
Functional Unit Explanation	Collecting and transporting one ton of waste in Gothenburg city.
Process Type	Cradle to grave
Site	Gothenburg, Sweden
Sector	Sector
Owner	Gothenburg, Sweden
Technical system description	Excerpt from the report (for report see link below): ''2.2.1 Options Three types of waste collection vehicles were compared: · A diesel waste collection vehicle · A gas waste collection vehicle · A gas-electric hybrid waste collection vehicle (..) the hybrid vehicle runs using the gas engine but turns the engine off and uses electric power from two lead batteries via an electric motor when loading. The combustion engine is turned off 30 seconds after the vehicle has stopped and the electric motor is used only when loading and compacting waste. Charging of the batteries is mainly done at night from the electric net, but it can also be done, if needed, with power from the combustion engine during operation. The vehicles consist of a truck chassis from Volvo AB, model FL6E, and a waste collection unit, i.e. the container and waste loading equipment on the truck, from Norba AB, model RL 200L.'' ''When a waste collection vehicle stops to collect waste, the combustion engine is kept running and is used to lift the waste into the truck and to compact it. This also means that the vehicle idles for a considerable amount of time when the workers collect waste bins, emitting pollutants without doing any work. The collection is often also considered noisy by people in the vicinity. According to measurements at Renova, the time a waste collection vehicle stands still accounts for about 60 percent of the total working time when operating in the central parts of Gothenburg (Österman, 2002). In 2002, Renova, together with Volvo AB, Norba AB and ETP AB, started to develop a vehicle that uses natural gas when running, but automatically turns the combustion engine off when it has stopped and uses electricity to load and compact the waste. Using this technique reduces air emissions and noise in the vicinity of the collection sites.'' Figure 5 in the report shows a flow chart of the life cycle of the vehicles.

	Some facts about the diesel (and gas) vehicle (Table 1 in the report): Truck model: Volvo FL6E Waste collection unit model: Norba RL 200L Manufacturing year: 2003 Service Weight: 12 170 kg Loading capacity: 5 830 kg Engine power: 150 kW Emissions control: Catalytic converter This process is included in the system described in Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden at http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf Other processes in the CPM Database also included in the above publication: Truck chassi manufacturing. ESA-DBP Truck tire production. ESA-DBP Transportation with diesel driven waste collection vehicle. ESA-DBP Transportation with gas driven waste collection vehicle. ESA-DBP Transportation with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection area driving, with diesel driven waste collection vehicle. ESA-DBP Collection area driving, with gas driven waste collection vehicle. ESA-DBP Collection area driving, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Collection stop, with diesel driven waste collection vehicle. ESA-DBP Collection stop, with gas driven waste collection vehicle. ESA-DBP Collection stop, with hybrid (gas-electric driven) waste collection vehicle. ESA-DBP Waste collection vehicle, diesel driven. ESA-DBP Waste collection vehicle, driven by compressed natural gas. ESA-DBP

System Boundaries

Nature Boundary	Excerpt from the report (for report see 'Publication'): ''The LCA covers all of the life cycle of the waste collection vehicles from the cradle, when raw materials are extracted, to the grave, end-of-life treatment of the used vehicle.''
Time Boundary	Excerpt from the report (for report see 'Publication'): ''The assessment focuses on the technical system of today with a few years' perspective; data from the recent years were used, and the lifetime of a vehicle was assumed to be ten years.'' NB: The report is written in 2004 and 2005.
Geographical Boundary	The study is limited to waste collection in central Gothenburg, Sweden.
Other Boundaries	Excerpts from the report (for report see 'Publication'): ''The LCA covers all of the life cycle of the waste collection vehicles from the cradle, when raw materials are extracted, to the grave, end-of-life treatment of the used vehicle. Maintenance and repair was also accounted for. Concerning the end-of-life treatment, sorting into different material fractions was included whereas re-melting to produce another product was allocated to the new product, thus not accounted for.'' NB: The waste treatment (e.g. burning) of the collected waste was not included in the life cycle of the waste collection vehicle. ''Environmental impacts from the manufacturing of capital goods, such as machines used in the manufacturing of the vehicles, were not considered, nor were impacts from activities of employees.'' ''The study is limited to waste collection in central Gothenburg, using a Volvo chassis of model FL6E with a Norba waste collection unit of model RL 200L. The gas vehicles were assumed to use natural gas (not biogas). Environmental impacts from noise or odour were not considered.''
Allocations	Excerpts from the report (for report see 'Publication'): ''Concerning the end-of-life treatment, sorting into different material fractions was included whereas re-melting to produce another product was allocated to the new product, thus not accounted for.'' ''Allocations in material production were mainly based on weight and in vehicle manufacturing processes, on number of products.'' ''Most of the disassembled parts are transported to the fragmentation facility at Stena fragmentering AB in Halmstad, Sweden. The facility treats a wide variety of scraps, of which about one third is vehicle scrap (Stena fragmentering AB, 2005). Stena fragmentises and sorts the scrap into separate material fractions. Allocation of environmental impacts was based on weight of the unsorted scrap input to the facility. The amount of sorted scrap from a vehicle out from the fragmentation facility was calculated from the total amount of metals in the vehicle and multiplying this by the degree of recycling. The total amount of sorted scrap from the facility was 137 930 tons. The total amount of the residuals including metals that could not be sorted out was 52 928 tons (Stena fragmentering AB, 2005) and the metal fraction in the residuals was 8% (Eskilsson, 2002). This gave the degree of recycling for metals: 137 930 / (137 930+52 928·0.08) = 97%''

Systems Expansions	Excerpt from the report (for report see 'Publication'): "A few system expansions were used to account for excess energy produced in some processes."

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, mixed
Represents	See 'Function'.
Method	Excerpt from the report: "2.3.2 Data collection From the use phase, data from direct measurements carried out at Renova of the studied vehicles were available. Also for the maintenance and repair, data from Renova were used. Data concerning production and end-of-life treatment were collected by personal communication, from annual environmental reports and from previous life cycle assessment reports. The main calculations were carried out in the LCA software LCAiT (CIT Ekologik, 2003), where some general data also were included." NB: Chapter 2.3.2 is a chapter in the report. The reference (CIT Ekologik, 2003) can be found in the report.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	The flow table here is a shortened version of the flow table in the report. All values for resources above 0.01 kg and for emissions above 0.001 kg is in this table. All values with the unit Bq is excluded.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Lead scrap	-0.0382			kg	Technosphere	
	Input	Refined resource	Oxygen	0.0125			kg	Technosphere	
	Input	Refined resource	Steel scrap	-0.203			kg	Technosphere	
	Input	Resource	Bauxite	0.0476			kg	Ground	
	Input	Resource	Coal	0.143			kg	Ground	
	Input	Resource	Crude oil	0.357			kg	Ground	
	Input	Resource	Hard coal	0.171			kg	Ground	
	Input	Resource	Iron ore	0.575			kg	Ground	
	Input	Resource	Latex rubber	0.0729			kg	Ground	
	Input	Resource	Lead in ore	0.0382			kg	Ground	
	Input	Resource	Lignite	0.112			kg	Ground	
	Input	Resource	Limestone	0.0448			kg	Ground	
	Input	Resource	Natural gas	4.68			kg	Ground	
	Input	Resource	Olivine	0.0118			kg	Ground	
	Input	Resource	Sand	0.0168			kg	Ground	
	Input	Resource	Water	26.7			kg	Ground	
	Input	Resource	Wood	0.0399			kg	Ground	
	Output	Emission	Cl-	0.0313			kg	Water	
	Output	Emission	CO	0.0181			kg	Air	
	Output	Emission	CO2	14.5			kg	Air	
	Output	Emission	COD	0.00107			kg	Water	
	Output	Emission	Hydrocarbons	0.00662			kg	Air	
	Output	Emission	Methane	0.0235			kg	Air	
	Output	Emission	Na+	0.00801			kg	Water	
	Output	Emission	NMVOC	0.00118			kg	Air	
	Output	Emission	NOx	0.0514			kg	Air	
	Output	Emission	Particles	0.00138			kg	Air	
	Output	Emission	SO2	0.00417			kg	Air	
	Output	Emission	SO42-	0.0133			kg	Water	
	Output	Emission	VOC	0.00148			kg	Air	
Notes: To landfill.	Output	Residue	Concentration sand	0.524			kg	Technosphere	
	Output	Residue	Dust	0.00408			kg	Technosphere	
Notes: To landfill.	Output	Residue	Granite	0.398			kg	Technosphere	
Notes: Treated.	Output	Residue	Hazardous waste	0.00392			kg	Technosphere	
	Output	Residue	Hazardous waste	0.085			kg	Technosphere	

	Output	Residue	Household waste	0.0216			kg	Technosphere	
	Output	Residue	Inert residues	0.384			kg	Technosphere	
	Output	Residue	Landfill waste	0.144			kg	Technosphere	
Notes: To landfill.	Output	Residue	Margin ore waste	0.0608			kg	Technosphere	
	Output	Residue	Metal scrap	0.00622			kg	Technosphere	
	Output	Residue	Mineral waste	0.00396			kg	Technosphere	
	Output	Residue	Non magnetic waste	0.00415			kg	Technosphere	
	Output	Residue	Ore dressing residue	0.059			kg	Technosphere	
	Output	Residue	Plastics	0.00683			kg	Technosphere	
	Output	Residue	Plastics and electrolyte in lead battery	0.051			kg	Technosphere	
	Output	Residue	Red mud	0.00143			kg	Technosphere	
	Output	Residue	Rubber	0.00514			kg	Technosphere	
	Output	Residue	Rubber tire	0.138			kg	Technosphere	
	Output	Residue	Salt	0.00111			kg	Technosphere	
Notes: LD-slag (Linz-Donawitz)	Output	Residue	Slag	0.00707			kg	Technosphere	
	Output	Residue	Slag	0.175			kg	Technosphere	
	Output	Residue	Slags and ashes	0.00175			kg	Technosphere	
Notes: LD-sludge (Linz-Donawitz)	Output	Residue	Sludge	0.00556			kg	Technosphere	
	Output	Residue	Sludge	0.0085			kg	Technosphere	
	Output	Residue	Solid waste	0.531			kg	Technosphere	
	Output	Residue	To incinerator	0.0039			kg	Technosphere	
	Output	Residue	Treated waste	0.0124			kg	Technosphere	
	Output	Residue	Unspecified waste	0.295			kg	Technosphere	
	Output	Residue	Waste deposit	0.0814			kg	Technosphere	

About Inventory

Publication	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--7.pdf
Intended User	Renova AB and LCA practitioners
General Purpose	Excerpt from the report (for report see 'Publication'): ''The waste and recycling company Renova AB has developed a new type of waste collection vehicle, which has been used and evaluated for waste collection in central Gothenburg for a few years. What distinguishes this type of vehicle from conventional waste collection vehicles is, firstly, that it uses natural gas to drive instead of diesel, and secondly, that it turns the combustion engine off at the collection stops and uses electric power to load and compact waste. In this master's thesis the environmental performance of such a gas-electric hybrid waste collection vehicle was evaluated in comparison with a conventional diesel vehicle and a natural gas vehicle without the hybrid technique.''
Detailed Purpose	Excerpt from the report (for report see 'Publication'): ''The goal of this LCA study was to evaluate the environmental impact from a waste collection vehicle running on natural gas and loading waste by using electricity when used in the central parts of Gothenburg.(...) The purpose of the study was to use the results as a platform for decisions of future waste collection within Renova AB - if hybrid vehicles should be used and what is most important to improve for minimisation of the environmental impact. The intended audience of the report is mainly personnel at Renova but also some suppliers are interested in the results.''
Commissioner	Renova AB & Chalmers University of Technology - .
Practitioner	Anna Boss - .
Reviewer	Carl Jensen, Renova AB and Karin Andersson, Chalmers -
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	Excerpts from the report (for report see 'Publication'): ''Renova uses the electric hybrid vehicles to collect waste in central Gothenburg and transport it to their waste incineration plant in Sävenäs (in Gothenburg). Specific measurements of emissions and energy use from this area were used. Electricity used in the hybrid vehicle was assumed to originate from average Swedish electricity production. In the production of the vehicle, both specific and general average data were used; see further in sections 3.1 and 3.2.'' ''Many parts, which often are replaced, are available at Renova's storage and these were weighed and the material contents were assessed by visual inspection and estimation. Missing parts with the same function as available ones were assumed to be similar to

	the available ones. Other parts were assessed in a discussion with Bengt Svensson at the workshop. Starter batteries were estimated to weigh 20 kg and the same material data were used as for the batteries in the electric hybrid equipment. In the work orders, tires are not included, but according to Jan Örn at the workshop (personal communication) they are usually replaced once every year. A set of tires weighs 370 kg according to Robert Svensson at Volvo (personal communication). The total materials used in maintenance and repair corresponding to a vehicle life cycle, not including extra material for hybrid equipment, are shown in Table 17. For the production of these materials the same general data were used as in the production phase of the vehicle (see section 3.1.1). ''Other chemicals'' are mainly windscreenwasher fluid and antifreeze and they have not been traced back to the cradle. Table 17. Materials used in maintenance and repair. Material Weight [kg] Steel 1150 Aluminium 95 Copper 0.86 Plastics 163 Rubber (mainly tires) 3390 Glass 22.7 Paper 2.7 Lead batteries 106 Oil 1130 Other chemicals 535 litres The batteries in the electric hybrid can be charged about 1000 times (Österman, 2002), which is not enough for the entire life of the vehicle. In this study it was assumed that the batteries will be replaced twice during a lifetime of ten years. Calculations for the extra repair needed on hybrid vehicles are based on the production and waste of two extra sets of batteries. The waste generated during maintenance and repair was estimated from the materials consumed. The amounts of scrap was estimated by using the same degree of recycling of metals as in the end-of-life treatment of the vehicle at Stena fragmentering, 97% (compare section 3.5). The metal fractions not recycled were assumed to be landfilled. Oil and other chemicals were presented as hazardous waste. The same amounts as used of tires, plastics, paper and glass respectively, were presented as waste of those materials. No further analysis of the waste was carried out, except for batteries (both starter batteries and hybrid equipment batteries), which are transported to Boliden Bergsöe in Landskrona, Sweden, as in section 3.5.'' ''Most of the disassembled parts are transported to the fragmentation facility at Stena fragmentering AB in Halmstad, Sweden. The facility treats a wide variety of scraps, of which about one third is vehicle scrap (Stena fragmentering AB, 2005). Stena fragmentises and sorts the scrap into separate material fractions. Allocation of environmental impacts was based on weight of the unsorted scrap input to the facility. The amount of sorted scrap from a vehicle out from the fragmentation facility was calculated from the total amount of metals in the vehicle and multiplying this by the degree of recycling. The total amount of sorted scrap from the facility was 137 930 tons. The total amount of the residuals including metals that could not be sorted out was 52 928 tons (Stena fragmentering AB, 2005) and the metal fraction in the residuals was 8% (Eskilsson, 2002). This gave the degree of recycling for metals: 137 930 / (137 930 + 52 928·0.08) = 97%'' ''The transportation to Stena fragmentering was assumed to be accomplished by truck and the distance from Gothenburg to Halmstad is 145 km. The recycling processes of the fragmentised scrap metals were allocated to material production for a future product, i.e. not included in this study. The batteries are sent from Gothenburg to Boliden Bergsöe in Landskrona, Sweden for lead recycling. It was assumed to be transported by truck, 244 km. The lead scrap from the batteries is presented as a negative input and the other materials in the batteries are presented as waste, but the recycling process was not included since it was allocated to production of new lead. For the rest of the hybrid electric equipment, waste is given according to the materials it consists of, with a 97% degree of recycling for metals (assumed to be the same as for the vehicle scrapping at Stena fragmentering). The residual metals were assumed to go to landfill, chemicals are presented as hazardous waste, and the rest of the materials used are presented as waste of the same materials. The waste was not further analysed.'' ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Excerpt from the report (for report see 'Publication'): ''The conventional gas vehicle and the hybrid vehicle use compressed natural gas as fuel. When the terms ''gas vehicle'' or ''gas engine'' are used in this report they refer to a vehicle running on natural gas (and should not be confused with petrol).

SPINE LCI dataset: Waste disposal

Administrative	
Finished	Y
Date Completed	1996-03-01
Copyright	
Availability	Public

Technical System	
Name	Waste disposal
Functional Unit	1996
Functional Unit Explanation	The data in the table represents the total waste that has been disposed during the time 1996-03-02 - 1997-03-01. The waste admitted by Tyft: Solid waste (compressed) 55m3 Dewatered sludge 1540 m3 Latrine 20 m3 Combustible waste 4177 ton Sorted out and, in some cases, recycled: Paper (recycled) 495 ton Glass (recycled) 234 ton Batteries (recycled) 2 ton Scrap 386 ton Refrigerators 818 pcs Fabrics 33 ton Fluorescent lamps 4802 pcs Electronical scrap 13, 754 ton Carboard (recycled) 118 ton Corrugated cardboard 155 ton Metal packages (recycled) 4 ton Plastic packages (recycled) 3 ton Tyres 46000 pcs Splinter 2500 m3 Hazardous waste 10,300 ton Waste oil 27 m3
Process Type	Gate to gate
Site	The municipality of Tanum Pl 2538 457 91 Tanumshede Sweden
Sector	Waste management
Owner	The municipality of Tanum Pl 2538 457 91 Tanumshede Sweden
Technical system description	Tyft waste disposal plant, sorts, dumpes and stores waste. A detalied description of the plant follows below. The municipality has 9700 houses, where 4725 has its own compost (registrated at the end of 1996). The plant is situated about 7,5 km ouside Tanumshede population centre. The total area is 240 ha and the dump area 7 ha. The area is drained to Gramsälven, that changes name further down to Anråsälven and flows into Fjällbackafjorden, north of Fjällbacka. The nearest house is at a distance of 500 m and there are five houses within a radius of one km. The waste consists of household waste, waste from offices and shops, building waste, industrial waste, latrine, sludge and some business related waste as plush and panel from Volvo, plastics from Inventing and film reels from Extra Film. Business related waste that can be recycled or is harzadous is sorted out. The rest is,

	together with the household waste, transported to a combustion plant in Göteborg. Non-combustible waste, as plaster and insulating material is dumped in the area. The sludge is dewatered at the purification plant in Tanum. The dewatered sludge is composted at a special site in the area. Composted material is used as landfilling, though no sludge has been used in parks or agricultures. The white goods that contain CFC:s is temporarily stored at Tyft, and about 2-3 times a year transported to the recycling plant in Halmstad. The white goods and electronics is collected at the houses. The waste oil is collected in a special oil tank and temporarily stored, together with chemicals and other hazardous waste. Scrap and splinter are dumped.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires. Non combustable waste like plaster, insulating material etc is dumped within the area. The amount is not specified in the environmental report.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	Eventually the hazardous waste is collected by Traab.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	See 'Function'.
Method	Study the Environmental Report from Tyft in the municipality of Tanum for 1996, The Board of County in Göteborg and Bohus. The amounts in the table are taken directly from the environmental report, and shows the resourses, residues and emissions for the annual production of 1996. The emissions to water, Gramseälven, are analysed by AnalyCen Nordic AB (Box 11404, 404 29 Göteborg, Sweden, Phone +46 -31 613740, Fax +46 -31 150512). The total amount of water led to Gramseälven during 1996 was 22500 m3.
Literature Reference	Boss A, 2005, Life cycle assessment of a gas-electric hybrid waste collection vehicle - comparison with conventional waste collection vehicles. Environmental Systems Analysis report 2005:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--7.pdf
Notes	The data type unspecified implies that one does not know the origin of the data.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1996 Data type: Unspecified Notes: Is recycled	Input	Refined resource	Batteries	2000			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is recycled	Input	Refined resource	Cardboard	118			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Consists among other things of household waste. Is transported to and combustioned in a combustion plant in Göteborg.	Input	Refined resource	Combustible waste	4177			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is recycled	Input	Refined resource	Corrugated cardboard	155			tonne	Technosphere	

Date concieved: 1996 Data type: Unspecified Notes: The dewatered sludge is composted in a certain place within the area. The composted material is used as cover material if there is no other market for it.	Input	Refined resource	Dewatered sludge	1540			m3	Technosphere	
	Input	Refined resource	Fabrics	33			tonne	Technosphere	
	Input	Refined resource	Fluorescent lamp	4802			pce	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is recycled	Input	Refined resource	Glass	234			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is taken away by Traab.	Input	Refined resource	Hazardous waste	10300			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is recycled	Input	Refined resource	Metal package	4			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is recycled	Input	Refined resource	Plastic package	3			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The electronics are brought from the homes on special collection routes to Tyft	Input	Refined resource	Scrap-Electronics	13754			kg	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is recycled	Input	Refined resource	Scrap-metal	386			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: (Latrine), is dumped at Tyft.	Input	Refined resource	Sewage	20			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Compressed volume	Input	Refined resource	Solid waste	55			m3	Technosphere	
	Input	Refined resource	Tyres	46000			g	Technosphere	
	Input	Refined resource	Waste oil	27			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: Is recycled	Input	Refined resource	Waste paper	498			tonne	Technosphere	
Notes: Refrigerators and freezers are brought from the homes on special collection routes and are then temporarily stoored at Tyft. The white goods are transported to a freone recycling plant in Halmstad. This is done 2-3 times a year.	Input	Refined resource	White goods	818			pce	Technosphere	
	Input	Refined resource	Wooden chips	2500			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The emissions are let out in Gramseälven.	Output	Emission	BOD	562			kg	Water	
Date concieved: 1996 Data type: Unspecified Notes: The emissions are let out in Gramseälven.	Output	Emission	N	630			kg	Water	
Date concieved: 1996 Data type: Unspecified Notes: The emissions are let out in Gramseälven.	Output	Emission	P	7.2			kg	Water	
Date concieved: 1996 Data type: Unspecified Notes: The emissions are let out in Gramseälven.	Output	Emission	TOC	1620			kg	Water	
Date concieved: 1996 Data type: Unspecified Notes: Is recycled	Output	Residue	Waste paper	768			tonne	Technosphere	

About Inventory

Publication	Environmental report from Tyft, The municipal of Tanum, for 1996, The Board of County in Göteborg and Bohus -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden.
Practitioner	Sund, Stefan - The municipality of Tanum Pl 2538 457 91 Tanumshede Sweden.
Reviewer	- The Environmental Administration in the municipality of Göteborg Box 360 401 25 Göteborg Sweden
Applicability	For more information about the amounts that are dumped on the area contact the company.
About Data	The waste admitted by Tyft: Solid waste (compressed) 55m3 Dewatered sludge 1540 m3 Latrine 20 m3 Combustible waste 4177 ton Sorted out and, in some cases, recycled: Paper (recycled) 495 ton Glass (recycled) 234 ton Batteries (recycled) 2 ton Scrap 386 ton Refrigerators 818 pcs Fabrics 33 ton Fluorescent lamps 4802 pcs Electronical scrap 13, 754 ton Carboard (recycled) 118 ton Corrugated cardboard 155 ton Metal packages (recycled) 4 ton Plastic packages (recycled) 3 ton Tyres 46000 pcs Splinter 2500 m3 Hazardous waste 10,300 ton Waste oil 27 m3
Notes	

SPINE LCI dataset: Waste disposal of building, industrial and hazardous waste

Administrative	
Finished	Y
Date Completed	1997-03-01
Copyright	
Availability	Public

Technical System	
Name	Waste disposal of building, industrial and hazardous waste
Functional Unit	ton

Functional Unit Explanation	1ton dewatered industrial waste consisting of: Industrial waste 5,4% Industrial sludge 7,5% Paint waste 7,9% Spolgropsavfall 17,0% Mechanical wood-pulp 32,0% Metal hydroxide sludge 23,2% Contaminated soil 7,0%
Process Type	Gate to gate
Site	Reci Industri AB The refuse dump of Torsviken Pl 8743 417 91 Göteborg Sweden
Sector	Waste management
Owner	Reci Industri AB The refuse dump of Torsviken Pl 8743 417 91 Göteborg Sweden
Technical system description	Reci Industri AB recives solid industrial waste, contaminated soil, industrial sludge, solid/half solid paint waste, mechanical wood-pulp, waste water from car washes etc. and metal hydroxide slam. Waste transported to Torslanda is dumped in different reservoirs depending on its contents. Leachate from the area is pumped into the internal sewage treatment works, where it is treated with calcium oxide. The area is situated in a depression. Torsviken is a bay, but the dumping area is as a whole placed on solid ground. The total area amounts to 16 ha, and is bounded to the north by a road, to the east by a mountain ridge, to the south by Göteborgs Hamn's dredge dump and to the west by Torslanda airfield. The surface layer at the dump consists of fine sediment and clay. The upper layer contains organic material and mud and has a thickness of about 1 m in the center of the area. Below the mud there is clay, which at the south of the depression amounts to a thickness of 25 m. The surface water in the area is naturally drained by a brook that passes through the dumping area. The dump is surrounded with banks built of noncombustible material. The banks are packed with 0,5 m thick layer of clay on the inside. The layer of clay connects to the natural layer in the ground so that no leachate will not leak out from the area.

System Boundaries

Nature Boundary	The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires. The surrounding nature can be seen as a part of the system because it works as a waste dump for all the substances. The ground also in some cases serves as a filter, which purifies the water. The cleansed leach water, from the sewage treatment works, is led to Göteborgs Hamn's dredge dump. Measurements concerning air emission have been done but are not documented in the report. Though they are reported to be below the legislated limit for urban areas. Measurements concerning noise have been done but are not documented in the report. Though they are reported to be below the legislated limit for external industry noise established by Swedish Environmental Protection Agency. There are no dwelling-houses in the surrounding area. The noise arises while transporting and loading the waste.
Time Boundary	The company is obligated to write an Environmental report once every year. Though the legislated limits can be changed only if the activity is changed.
Geographical Boundary	Sweden
Other Boundaries	The water treated in the internal sewage treatment works is led to Göteborgs Hamn's sludge dumping area.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	See 'Function'.

Method	Study the Environmental report The data in the table has been converted into amounts per functional unit. The data from the environmental report has therefore been devided by the annual production for 1996.
Literature Reference	The Environmental Report from Reci Industri AB for 1996, The Environmental Administration in the municipality of Göteborg, Sweden
Notes	The data type unspecified implies that one does not know the origin of all the data, see Specific QMetaData for information about each substance. Some of the emissions are based on arethmetic averages, these averages are wighted. It is not stated in what way, and what the weighting konstant is.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Date concieved: 1996 Data type: Unspecified Notes: The slaked lime is used to precipitate substanses.	Input	Refined resource	Ca(OH)2	0.002495221			tonne	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The diesel has the sulphur content 0,1%	Input	Refined resource	Diesel	0.002769093			m3	Technosphere	
Date concieved: 1996 Data type: Unspecified Notes: The polymer is used to cause a flocculoreaction.	Input	Refined resource	Duromax	0.0000741402			tonne	Technosphere	
	Input	Refined resource	Electricity	0.013934792			MWh	Technosphere	
Date concieved: 1996 Data type: Economical information Method: All the waste recived at Torsviken is weighted and the content is controlled visually or occasionally with random samples, which is analysed. Notes: 1ton dewatered industrial waste consisting of: Industrial waste 5,4% Industrial sludge 7,5% Paint waste 7,9% Spolgropsavfall 17,0% Mechanical wood-pulp 32,0% Metal hydroxide sludge 23,2% Contaminated soil 7,0%	Input	Refined resource	Industrial waste	1			tonne	Technosphere	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard DIM 38409-14. The margin of error for the method is 10%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: Swedish standard developed by The Swedish Environmental Protection Agency. DIM 38409-14	Output	Emission	AOX	0.00000169719			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard Mod ss 028150. The margin of error for the method is 20%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted.	Output	Emission	As	0.0000000142921			tonne	Water	

	Literature: Mod ss 028150 Swedish Standrad Swedish Environmental Protection Agency									
	Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028143-2. The margin of error for the method is 12%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028143-2 Swedish standard is developed by The Swedish Environmental Protection Agency.	Output	Emission	BOD	0.0000714605			tonne	Water	
	Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028184. The margin of error for the method is 9,3%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028184 Swedish standard is developed by Swedish Environmental Protection Agency.	Output	Emission	Cd	0.000000000357302			tonne	Water	
	Date concieved: 1996 Data type: Average from several samples Method: According to Swedish standard ss 028142-2 . The margin of error for the method is 2,9%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028142-2 Swedish standard developed by The Swedish Environmental Protection Agency Notes: The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period.	Output	Emission	COD	0.000634212			tonne	Water	
	Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028184. The margin of error for the method is 2,3%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the	Output	Emission	Cr	0.0000000116123			tonne	Water	

specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028184 Swedish standard developed by The Swedish Environmental Protection Agency									
Date concieved: 1996 Data type: Monitored data, discrete Method: The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. The analyse method is not described. Literature: Swedish standard developed by The Swedish Environmental Protection Agency.	Output	Emission	Creosote	0.0000000321572			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028184. The margin of error for the method is 7,0%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028184 Swedish standard developed by The Swedish Environmental Protection Agency	Output	Emission	Cu	0.000000031264			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028129. The margin of error for the method is 2,9%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028129 Swedish standard developed by The Swedish Environmental Protection Agency	Output	Emission	Fe	0.000000589549			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028175. The margin of error for the method is 20%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h	Output	Emission	Hg	0.000000000714605			tonne	Water	

test period. The arithmetic average value is weighted. Literature: ss 028175 Swedish standard developed by The Swedish Environmental Protection Agency.									
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028130. The margin of error for the method is 1,7%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028130 Swedish standard developed by The Swedish Environmental Protection Agency	Output	Emission	Mn	0.0000000410898			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028184. The margin of error for the method is 6,1%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028184 Swedish standard developed by The Swedish Environmental Protection Agency	Output	Emission	Ni	0.000000625279			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ISO 5663 + EPA 300.0. The margin of error for the method is 10%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ISO 5663 + EPA 300.0 Swedish standard developed by The Swedish Environmental Protection Agency.	Output	Emission	N-tot	0.0000625279			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The amount is built on an geometric average. Literature: Swedish standard	Output	Emission	Oil	0.000000455561			tonne	Water	

developed by The Swedish Environmental Protection Agency. Notes: Mineral oil.									
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028184. The margin of error for the method is 12,6%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028184 Swedish standard developed by The Swedish Environmental Protection Agency.	Output	Emission	Pb	0.00000000535954			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard SNV 3829. The margin of error for the method is 25%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: SNV 3829 Swedish standard developed by The Swedish Environmental Protection Agency.	Output	Emission	PCB	0.000000000267977			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard SIS 028128. The margin of error for the method is 10%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: SIS 028128 Swedish standard developed by The Swedish Environmental Protection Agency.	Output	Emission	Phenol	0.000000455561			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028127-2. The margin of error for the method is 2,4%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028127-2 Swedish standard developed by The Swedish Environmental	Output	Emission	P-tot	0.00000116123			tonne	Water	

Protection Agency.									
Date concieved: 1996 Data type: Single sample Method: Accordins to Swedish standard ss 028112-3. The margin of error for this method is 20%. The sample has been taken from the leachate after the sediment basin, which is located after the sewage treatment works. Literature: ss 028112-3 Swedish standard developed by The Swedish Environmental Protection Agency	Output	Emission	Susp solids	0.00000196516			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028145-3. The margin of error for the method is 5%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The geometric average value is weighted. Literature: ss 028145-3 Swedish standard developed by The Swedish Environmental Protection Agency.	Output	Emission	TEX	0.0000125056			tonne	Water	
Date concieved: 1996 Data type: Monitored data, discrete Method: According to Swedish standard ss 028152-2. The margin of error for the method is 11,7%. The sample has been taken at the outlet from the sewage treatment works. The instrument, which takes the specimens, is controlled by time and takes five samples per hour. The water flow is kept constant during the 24 h test period. The arithmetic average value is weighted. Literature: ss 028152-2 Swedish standard developed by The Swedish Environmental Protection Agency.	Output	Emission	Zn	0.0000000267977			tonne	Water	

About Inventory

Publication	Environmental Report from Reci Industri AB for 1996, The Environmental Administration in the municipality of Göteborg, Sweden -- Data documented by: Maria Erixson and Sara Ågren, project employed for the database projet at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	To show the environmental load
General Purpose	The purpose of the Environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make shore that the company comply with the decision.
Detailed Purpose	To control that the legislated limits are not exceeded.
Commissioner	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg. .
Practitioner	Hell, Mati - Reci Industri AB The refuse dump of Torsviken Pl 8743 417 91 Göteborg Sweden.
Reviewer	- Swedish government via The Board of County in Göteborg and Bohus or The Environmental Administration in the municipality of Göteborg.

Applicability	The substances that are dumped in the area and not let out with the leachate, are not specified. The data is only useful in the cases where the waste in question has about the same composition as in this case.
About Data	The total amount of water passing the measure point during the year is 25 545 m3. The average water conductivity is 277 mS/m, the samples are analysed according to SIS 028123 with a margin of error of 10%. The average water temperature is 8,0°C. The average pH is 11,3, the samples are analysed according to ss 028122-2 with a margin of error of 5%. The measuring instrument is calibrated and inspected once a month.
Notes	

SPINE LCI dataset: Waste to energy plant

Administrative	
Finished	Y
Date Completed	99-08-30
Copyright	
Availability	Public

Technical System	
Name	Waste to energy plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a waste to energy plant located in Sweden. Municipal and industrial waste incinerated in the plant is converted into steam. Some of the steam is delivered to an industry, some is converted into heat and delivered to a district heating network. The plant fulfils two purposes; by getting rid of the waste and by recovering energy from the incineration. The waste to energy plant is used as base load for this district heating network system. TECHNICAL DATA FOR THE STUDIED PLANT: Avarage annual time of use (hours): - Total thermal output (MW): 33+22+5+5 Annual total fuel use (ton): 231 000 Annual total fuel use (MWh): ca 740 000 Normal annual production of heat (MWh): 594 000 Degree of thermal effieciecny (%): 80 PROCESS DESCRIPTION: The plant consists of four incineration units, two larger and two smaller ones, with a total thermal effect of 65 MW. Each unit has a furnace equiped with a stoker for incineration and a steam boiler. The dust is removed from the flue gas in an electrostatic precipitator, where about 99 % of the dust (fly ash) is removed. The flue gas from all four units are then led to a waste heat boiler which decreases the flue gas temperature and recovers about 9 MW heat. In order to clean flue gas from dust, hydrochloric acid, hydrofluoric acid, mercury and other heavy metals, the flue gas is then led to a wet scrubber/condensation flue gas cleaning

	system. This system operates at acidic conditions and is therefore adjusted to firstly remove hydrochloric acid and mercury. Sulphur dioxide is not removed in this step, but can be removed from a similar system operating at neutral conditions. In the same unit about 20 MW heat from the condensation process is produced. The heat is absorbed using absorption heat pump systems. Water from the condensor is cleaned in a conventional waste water treatment system before it is discharged to a river. Herefore some chemicals are used. Limestone and hydrated lime is used to neutralize the condensate. A flocculation agent, a polymer, is added to bind the percipitated pollutants into large clusters. A precipitation agent is added to bind the heavy metals. After the scrubber/condenser the gas is reheated and passed to a final dry flue gas cleaning system consisting of a reactor and a fabric filter, in order to remove sulphur dioxide and dioxine. Hydrated lime and fly ash, removed from the electrostatic precipitator, and in some occations activated carbon, are injected. The cleaned flue gas is then reheated and led through the smokestack to the air. INCLUDED OPERATIONS: The process study consists of the following operations: -The pretreatment of the waste before incineration. -The feeding of the waste into the incineration process. -The incineration process. -The flue gas cleaning process, both wet and dry flue gas cleaning, including the separation of dust, HCl, SOx, heavy metals and dioxine. -The treatment of the condensate from the wet flue gas cleaning process, including the separation of heavy metals and dioxine. -The treatment of the residues from the incineration and cleaning process. -The internal consumption of electricity. -The internal consumption of chemicals used in the flue gas cleaning system, with the exemption of chemicals for feed water treatment. NOx CONTROL: - The boilers are equiped with SNCR systems with urea as the reducing agent. Two of the boilers are equiped with flue gas recirculation. - SNCR (Selective Noncatalytic Reduction) describes a method for reducing the NOx already formed during the combustion process. In the process, an aqueous reduction agent mixed in water or steam is injected into the furnace during the combustion process. The reduction agent reduces the NOx and forms nitrogen and water. - Flue gas recirculation describes a method for limiting the NOx-formation during the combustion process. The process involves temperature and air supply optimization OTHER FLUE GAS CLEANING SYSTEMS: For the removal of dust from the flue gas an electrostatic precipitator is used. In an electrostatic precipitator the dust particles are electrified and then separated from the flue gas stream by passing through an electric field with largest possible intensity. In order to clean flue gas from dust, hydrochloric acid, hydrofluoric acid, mercury and other heavy metals, the flue gas is also led to a wet scrubber/condensation flue gas cleaning system.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. Waste to Energy Plants, unlike most heating plants with other fuels, are obliged to measure and report certain emissions such as heavy metals, clorides and dioxine. Other emissions, like COD, that are not measured, are therefore not reported here.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data mainly from 1995. The data consists of average data on a year basis. This data is assumed to be valid until the enforcement of the new European Community regulations for Waste to Energy Plants in the EC countries, or until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION (for large technical systems): This inventory has been conducted on a Waste to Energy Plant in Sweden, with swedish regulations, applicable during 1995. The collected data should only be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat and process steam (and electricity) from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the chemicals used in the plant. - The cradle to gate of the internal electricity consumption. - The chemicals used for feed water treatment. - The water consumption in the processes. - The formation of the waste in households, industries etc. - The transportation of the waste from the ''waste producers'' to the Waste to Energy Plant. - The transportation of the residues from the incineration and cleaning process to the landfill. - The process at the landfill such as leaching, decomposition etc. The reduction system of nitrogen oxides has not been included in the system Waste to Energy Plant. The reduction system of nitrogen oxides has been treated as separate unit

	operations.
Allocations	PRINCIPLE APPLIED: In a heating plant one product of economic value is produced, heat. For operation and maintenance of the plant the use of resources and emissions are associated to the net production of heat.
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study)

Flow Data

General Activity QMetaData

Date Conceived	1995-01-01
Data Type	
Represents	See 'Function'.
Method	All data reported here is related to the functional unit 1 kWh heat produced in the heating plant. The data is originally given as the total yearly amount of an input (waste, chemicals, electricity etc.) to or an output (emissions to air and water, residues etc.) from the Waste to energy Plant. The inputs and outputs are then related to the functional unit by dividing the total yearly amount with the yearly amount of produced heat. For some flows specific information is given, see each flow.
Literature Reference	Data is in general recieved from ''Miljörapport 1995, Uppsala Energi AB, Fyriskraft AB, 1996-03-28'' and ''Sorterat avfall = Energi, Miljöanpassad energiåtervinning - praktikfall Uppsala, Kia Soisalo, Uppsala, 1996''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported in the environmental report is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Data type: Monitored data, continuous	Input	Refined resource	Electricity	0.041			kWh	Technosphere	
Data type: Monitored data, discrete Method: The measuring method used is unknown. Notes: The flocculation agent used is a polymere. The amount is given as a 50 percent solution.	Input	Refined resource	Flocculation agent	0.000307			g	Technosphere	
Data type: Monitored data, discrete Method: The measuring method used is unknown. Notes: The amount of hydrated lime reported, includes both the amount used in the water treatment process for the cleaning of the condensate, and the amount used in the dry flue gas cleaning system.	Input	Refined resource	Hydrated lime	1.19			g	Technosphere	
Data type: Monitored data, discrete Method: The measuring method used is unknown.	Input	Refined resource	Limestone	1.75			g	Technosphere	
Data type: Monitored data, discrete Method: The measuring method used is unknown. Notes: The precipitation agent used is an organic sulphide (TMT). The amount is given as a 15 percent solution.	Input	Refined resource	Precipitation agent	0.0209			g	Technosphere	
Data type: Monitored data, continuous Method: Every transport of waste is weighed at the plant and reported in the Environmental Report.	Input	Refined resource	Waste	388			g	Technosphere	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	Cd	0.000000656			g	Water	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	Co	0.00000104			g	Water	

Data type: Monitored data, continuous Method: This emission is measured continuously. The value for CO is originally given in mg/Nm3 in the flue gas. The value has then been calculated by multiplying the value in mg/Nm3, with the amount of flue gas given per ton waste incinerated (Here 5400 Nm3/ton waste is used for this plant). Literature: Data is picked from ''Svensk avfallsförbränning 1994-1995, Miljö och ekonomi. RVF Rapport 97:1, 1997''.	Output	Emission	CO	0.107			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continuously. Notes: This value is the fossile amount (netto) of CO2, based on the assumption that household wastes mostly contains materials of biological origin. About 20 % have fossile origin. The total amount of CO2 (brutto) is about 1,13315 kg/ton waste.	Output	Emission	CO2	404			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	Cr	0.00000000138			g	Water	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	Cu	0.0000129			g	Water	
Data type: Single sample Method: This emission is measured once yearly at the periodical inspection. The yearly amount of the emission is then estimated from this single sample.	Output	Emission	Dioxine	0.000000034			g	Air	
Data type: Single sample Represents: Value measured in 1996. Literature: Data is recieved from the report ''Avfallsförbränningen, Periodisk besiktning 1996, METLAB miljö AB, Laboratorium för Miljö- och Energiteknik, 1996''. Notes: The reported value is below the detection value of the measuring device.	Output	Emission	Dioxine	0.000171			g	Water	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	Dust	0.00680			g	Air	
	Output	Emission	HC	0.0118			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	Hg	0.000000133			g	Water	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	NH3	0.00477			g	Water	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	Ni	0.00000145			g	Water	
Data type: Monitored data, continuous Method: This emission is measured continously.	Output	Emission	NOx	0.243			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	Pb	0.00000216			g	Water	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	SO2	0.278			g	Air	

Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	Zn	0.0000122			g	Water	
Data type: Monitored data, continuous Notes: Reported in the Environmental Report as steam delivered to the industry, and heat delivered to the district heating net .	Output	Product	Heat	1			kWh	Technosphere	
Data type: Monitored data, continuous	Output	Residue	Bottom ash	73.5			g	Technosphere	
	Output	Residue	Fly ash	8.37			g	Technosphere	

About Inventory	
Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plant with different capacities.
Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: In 1997, there were 21 Waste to Energy Plants in Sweden. Data from these plants have been collected and analysed, regarding environmental parameters. From the study the conclusion can be drawn, that emission of environmental pollutants depends solely on the national regulations regarding waste to energy plants. Therefore the variation of emissions from these plants are small. The European Community is now working out new regulations that are to be valid for waste to energy plants in all countries of the EC. These regulations will probably be much stricter than today in Sweden. Therefore data from a plant was selected, that already today fulfils the expected new regulations. The collected data should therefore only be used for swedish conditions. The expected EC-regulations will probably result in waste to energy plants equipped with both wet and dry flue gas cleaning systems. Today only two waste to energy plants are equipped with wet and dry flue gas cleaning systems, the others have either a wet or a dry cleaning system. EMISSIONS FROM WASTE INCINERATION: Household waste and other waste contain pollutants such as cloride, sulphur and heavy metals (cadmium, mercurium etc), as a result of what is throwed away in the society. The containment of pollutants varies every day, from one place to another and depends on what kind of waste that is treated. For example, mercury could be found in some fluorescent lamps, and cadmium could be found in cadmium batteries. By incineration of the waste these pollutants comes into the flue gas or in the ash. The pollutants have to be removed from the flue gas by flue gas cleaning.
About Data	
Notes	

SPINE LCI dataset: Waste treatment - incineration for heat in cement kiln (SWEA CKN)

Administrative	
Finished	Y
Date Completed	2013-03-18
Copyright	CPM LCA Database - free to use but not to resell the data
Availability	Public

Technical System	
Name	Waste treatment - incineration for heat in cement kiln (SWEA CKN)
Functional Unit	1 kg waste fraction to incineration in cement kiln
Functional Unit Explanation	Data for the several separate waste fractions are available (see Technical system description).
Process Type	Gate to grave
Site	Sweden
Sector	Waste treatment
Owner	Sweden
Technical system description	This dataset represents Swedish BAT conditions in the period 2007-2010 for incineration of waste in cement kilns (CKN). It is a generic model applied to several waste fractions. The emissions from incineration are modeled for the incineration of the waste mix and further allocated to the specific waste fractions. Using data for incineration of only one specific fraction would not reflect the real situation, since the emission data for each fraction is valid in case of co-combustion with other fractions. Primary waste fractions: Chemical sludges and biosludges from industry 50%/50% (IndSludge Org), Paper and cardboard containers 14%, corrugated cardboard 30%, newsprint, journals and catalogues 42%, office paper 14% (Paper), Polyethylene, soft packaging (PE), PE 40%, PP 15%, PET 4%, PS 4%, PVC 11%, PUR 13%, PC 13% (Plastics), Rubber (Rubber), Wood excl. Transport pallets, excl. By-products e.g. reject from sawmill and tree felling, excl. Secondary wood waste from public recycling stations ÅVC (Wood) This model covers activities at the CKN plant. Waste collection (sorting and transporting) of incoming waste goods to the plant is not included. Heat energy generated is used for cement production and hence considered as avoided fuel and electricity production. The amount of ash and sludge generated is stated but treatment of this secondary waste in e.g. landfills is not included. For the secondary treatment of ash and sludge see the corresponding type of treatment e.g. landfill. That is, process models need to be linked in series. Internal technical system considered: The data reflect Swedish CKN plants' average operations. The kiln is assumed to be operating with a mix of all the waste fractions. Emissions and energy output are however provided for each specific waste fraction separately. Internal material consumption to operate the plant (e.g. machinery maintenance, etc.) is not included. The additives/chemicals consumption (e.g. lime, limestone, etc) necessary for incineration (emissions reduction) is included. Construction of capital goods e.g. buildings and machinery at the waste treatment facility is not included. Auxiliary facilities and operations such as offices and work travel are not included.

System Boundaries	
Nature Boundary	
Time Boundary	The modelled data is an approximation of BAT in Sweden in the period 2007-2010
Geographical Boundary	The model reflects the waste treatment system in Sweden.
Other Boundaries	See Technical system description
Allocations	As a base case, allocation is done on a material flow (mass) basis. That is, emissions are calculated in relation to the amount of a substance in each waste fraction. This is done for substances that are not transformed, where there is a mass balance. Other emissions are

	calculated in other ways depending on what was deemed the most relevant (allocated per MJ, or per total mass of the waste fraction). For landfill and incineration this is documented in Anna Björklund's licentiate thesis (Björklund A, 1998).
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Modeled data
Represents	Swedish BAT average operating conditions
Method	Inventory data was mainly collected from literature studies and results from previous related projects. Data has been remodeled to match the scope of SWEA. Some emission flow data were calculated with the ORWARE model (Björklund 1998; Eriksson et al. 2002).
Literature Reference	Download file with flows for all waste fractions at http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Björklund, A., Eriksson O., Ljunggren Söderman M., Stenmarck Å. and Sundqvist J-O (2009) "LCA of Policy Instruments for Sustainable Waste Management", Poster presentation, ISWA and Dakofa Conference Waste and Climate, Copenhagen, 2009. Björklund A, (1998), "Environmental systems analysis of waste management with emphasis on substance flows and environmental impact", Licentiate Thesis, Division of Industrial Ecology, Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden (ISSN 1402-7615, TRITA-KET-IM 1998:16, AFR-Report 211), 1998. Ekvall T, et al. (2006) "Towards Sustainable Waste Management - Programme plan", Project description, version 2006-04-09 as approved by Swedish EPA (Naturvårdsverket). Eriksson O, et al. (2002) "ORWARE - a simulation tool for waste management", Resources, Conservation and Recycling, Volume 36, Issue 4, November 2002, Pages 287-307. Ljunggren M (2000) "Modelling national solid waste management", Waste Management & Research 18:525-537, ISWA, December 2000 Östblom G, Berg C (2006) "The EMEC model: Version 2.0", Working Paper 96, National Institute of Economic Research, Stockholm, Sweden, 2006. Östblom G, (1999) "An Environmental Medium Term Economic Model EMEC", Working Paper 69, National Institute for Economic Research, Stockholm, Sweden, 1999.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported in the environmental report is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Waste	Waste	1			kg	Technosphere	Sweden

About Inventory

Publication	Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Flow data output for specific waste fractions from SWEA model : http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx
Intended User	LCA practitioners
General Purpose	Publication of data on Swedish waste treatement system
Detailed Purpose	See About data
Commissioner	Naturvårdsverket (Swedish EPA) - .
Practitioner	See About data - .
Reviewer	Tivander, Johan -
Applicability	For applicability for the process see 'Technical system description' and 'System Boundaries' above
About Data	This dataset is part of the Swedish Waste Management Environmental Assessment (SWEA) LCA model of the Swedish waste treatment system (Björklund et al. 2009; Arushanyan et al. 2013). The SWEA model covers several waste fractions and several waste treatments. It was developed in the Towards Sustainable Waste Management - TOSUWAMA (Hållbar Avfallshantering) research programme, funded by Swedish EPA (Naturvårdsverket) running 2006-2013 (Ekvall et al. 2006). The main contributors to the SWEA model: Ola Eriksson - Gävle University (HiG);

	Anna Björklund, Christine Ambell, Yevgeniya Arushanyan - Environmental Strategies Research, Royal Institute of Technology (FMS KTH); Jan-Olof Sundqvist, Åsa Stenmark, Maria Ljunggren Söderman - Swedish Environmental Institute (IVL) This dataset is part of several datasets from the SWEA model published in CPM LCA Database. The datasets are: Waste treatment - SWEA model - incineration in combined heat and power plant (CHP) Waste treatment - SWEA model - incineration in heat only boiler plant (HOB) Waste treatment - SWEA model - incineration for heat in cement kiln (CKN) Waste treatment - SWEA model - reactor composting (CPR) Waste treatment - SWEA model - windrow composting (CPW) Waste treatment - SWEA model - landfill (LFL) More information about the TOSUWAMA project is available at www.hallbaravfallshantering.se. This dataset was documented in the CPM LCA Database by Johan Tivander, Environmental Systems Analysis, Chalmers University of Technology, Sweden. Review by Johan Tivander considers CPM LCA Database documentation criteria.
Notes	

SPINE LCI dataset: Waste treatment - incineration in combined heat and power plant (SWEA CHP)

Administrative	
Finished	Y
Date Completed	2013-03-18
Copyright	CPM LCA Database - free to use but not to resell the data
Availability	Public

Technical System	
Name	Waste treatment - incineration in combined heat and power plant (SWEA CHP)
Functional Unit	1 kg waste fraction to incineration in CHP plant
Functional Unit Explanation	Data for the several separate waste fractions are available (see Technical system description).
Process Type	Gate to grave
Site	Sweden
Sector	Waste treatment
Owner	Sweden
Technical system description	This dataset represents Swedish BAT conditions in the period 2007-2010 for incineration of waste in combined heat and power plants (CHP) with incineration pan, heat and electric energy generator. It is a generic model applied to several waste fractions. The emissions from incineration are modeled for the incineration of the waste mix and further allocated to the specific waste fractions. Using data for incineration of only one specific fraction would not reflect the real situation, since the emission data for each fraction is valid in case of co-combustion with other fractions. Primary waste fractions (names in parenthesis correspond to names in the SWEA model): Animal waste from food industry (Animal), Paper and cardboard containers, (Cardboard) Corrugated cardboard (Corrugated cardboard), Discarded equipment including mainly metals and small amounts of plastic and rubber. Modeled as "metal mixed" (Equipment), Pulp (FibreReject), Food waste (Food), Glass container clear (Glass Clear), Glass container coloured (Glass Color), Gypsum (Gypsum), Hazardous waste from households waste bags (Hazardous), Other industrial effluent sludges inorganic (IndSludgeNOrg),

	Chemical sludges and biosludges from industry 50%/50% (IndSludgeOrg), Concrete, stone, bricks, not recycable (Inert mix), Metal waste, excluding the metal scrap from manufacturing, excluding return cans. The mix is: Aluminium 5%, ferrous metals (steel) 90%, stainless steel 2%, other metals modeled as copper 3% (Metal, mixed), Mixed municipal solid waste, the fractions and their shares are given in the corresponding data set (mixed MSW), Newsprint, journals, and catalogues (Newsprint), Sanitary products (diapers) and other combustible wood waste 24%/74% (OtherComb), Paper and cardboard containers 14%, corrugated cardboard 30%, newsprint, journals and catalogues 42%, office paper 14% (Paper, mixed), Park and yard waste with high heating value (Park, high HHV), Park and yard waste with low heating value (Park_h, low HHV), Polyethylene, soft packaging (PE), PE 40%, PP 15%, PET 4%, PS 4%, PVC 11%, PUR 13%, PC 13% (Plastics, mixed), Polystyrene (PS), Fibre recycling reject (RecFibRej), Rubber (Rubber), Public sewage sludge - digested (Sewage Sludge), Textile production waste (Textile), Vegetal waste from food processing (Vegetal), Wood excl. Transport pallets, excl. By-products e.g.reject from sawmill and tree felling, excl. Secondary wood waste from public recycling stations ÅVC (Wood) Secondary waste fractions: Reject from anaerobic digestion (CHP (reject from ADG) - (Animal, Foodsl, IndSludgeOrg, Manure, Vegetal) Reject from reactor composting (CHP (reject from CPR) - Animal, Foods, Park_h, Vegetal) Reject from windrow composting (CHP (reject from CPW) - Industrial sludge org, Manure, Park, SewSludge) This model covers activities at the CHP plant. Waste collection (sorting and transporting) of incoming waste goods to the plant is not included. Output heat and electricity energy is considered as delivered onto Swedish heating and electricity grid. Energy losses after point of delivery on the grid are not included. The amount of ash and sludge generated is stated but treatment of this secondary waste in e.g. landfills is not included. For the secondary treatment of ash and sludge see the corresponding type of treatment e.g. landfill. That is, process models need to be linked in series. Internal technical system considered: The data reflect Swedish CHP plants' average operations. The incineration furnace is assumed to be operating with a mix of all the waste fractions. Emissions and energy output are however allocated for each specific waste fraction separately. Internal energy consumption at the plant is included and is stated as "electricity input". Internal material consumption at the plant (e.g. greasing, fuel for machinery, filter changes etc.) is not included. Consumption of process additives/chemicals (e.g. lime, ammonia, etc.) necessary for incineration (emissions reduction) is included. Construction of capital goods e.g. buildings and machinery at the waste treatment facility is not included. Auxiliary facilities and operations such as offices and work travel are not included.

System Boundaries

Nature Boundary	
Time Boundary	The modelled data is an approximation of BAT in Sweden in the period 2007-2010
Geographical Boundary	The model reflects the waste treatment system in Sweden.
Other Boundaries	See Technical system description
Allocations	As a base case, allocation is done on a material flow (mass) basis. That is, emissions are calculated in relation to the amount of a substance in each waste fraction. This is done for substances that are not transformed, where there is a mass balance. Other emissions are calculated in other ways depending on what was deemed the most relevant (allocated per MJ, or per total mass of the waste fraction). For landfill and incineration this is documented in Anna Björklund's licentiate thesis (Björklund A, 1998).
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Modeled data
Represents	Swedish BAT average operating conditions

Method	Inventory data was mainly collected from literature studies and results from previous related projects. Data has been remodeled to match the scope of SWEA. Some emission flow data were calculated with the ORWARE model (Björklund 1998; Eriksson et al. 2002).
Literature Reference	Download file with flows for all waste fractions at http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Björklund, A., Eriksson O., Ljunggren Söderman M., Stenmarck Å. and Sundqvist J-O (2009) "LCA of Policy Instruments for Sustainable Waste Management", Poster presentation, ISWA and Dakofa Conference Waste and Climate, Copenhagen, 2009. Björklund A, (1998), "Environmental systems analysis of waste management with emphasis on substance flows and environmental impact", Licentiate Thesis, Division of Industrial Ecology, Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden (ISSN 1402-7615, TRITA-KET-IM 1998:16, AFR-Report 211), 1998. Ekvall T, et al. (2006) "Towards Sustainable Waste Management - Programme plan", Project description, version 2006-04-09 as approved by Swedish EPA (Naturvårdsverket). Eriksson O, et al. (2002) "ORWARE - a simulation tool for waste management", Resources, Conservation and Recycling, Volume 36, Issue 4, November 2002, Pages 287-307. Ljunggren M (2000) "Modelling national solid waste management", Waste Management & Research 18:525-537, ISWA, December 2000 Östblom G, Berg C (2006) "The EMEC model: Version 2.0", Working Paper 96, National Institute of Economic Research, Stockholm, Sweden, 2006. Östblom G, (1999) "An Environmental Medium Term Economic Model EMEC", Working Paper 69, National Institute for Economic Research, Stockholm, Sweden, 1999.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported in the environmental report is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Waste	Waste	1			kg	Technosphere	Sweden

About Inventory

Publication	Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Flow data output for specific waste fractions from SWEA model : http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx
Intended User	LCA practitioners
General Purpose	Publication of data on Swedish waste treatement system
Detailed Purpose	See About data
Commissioner	Naturvårdsverket (Swedish EPA) - .
Practitioner	See About data - .
Reviewer	Tivander, Johan -
Applicability	For applicability for the process see 'Technical system description' and 'System Boundaries' above
About Data	This dataset is part of the Swedish Waste Management Environmental Assessment (SWEA) LCA model of the Swedish waste treatment system (Björklund et al. 2009; Arushanyan et al. 2013). The SWEA model covers several waste fractions and several waste treatments. It was developed in the Towards Sustainable Waste Management - TOSUWAMA (Hållbar Avfallshantering) research programme, funded by Swedish EPA (Naturvårdsverket) running 2006-2013 (Ekvall et al. 2006). The main contributors to the SWEA model: Ola Eriksson - Gävle University (HiG); Anna Björklund, Christine Ambell, Yevgeniya Arushanyan - Environmental Strategies Research, Royal Institute of Technology (FMS KTH); Jan-Olof Sundqvist, Åsa Stenmark, Maria Ljunggren Söderman - Swedish Environmental Institute (IVL) This dataset is part of several datasets from the SWEA model published in CPM LCA Database. The datasets are: Waste treatment - SWEA model - incineration in combined heat and power plant (CHP) Waste treatment - SWEA model - incineration in heat only boiler plant (HOB) Waste treatment - SWEA model - incineration for heat in cement kiln (CKN) Waste treatment - SWEA model - reactor composting (CPR) Waste treatment - SWEA model - windrow composting (CPW) Waste treatment - SWEA model - landfill (LFL) More information about the TOSUWAMA project is available at

	www.hallbaravfallshantering.se. This dataset was documented in the CPM LCA Database by Johan Tivander, Environmental Systems Analysis, Chalmers University of Technology, Sweden. Review by Johan Tivander considers CPM LCA Database documentation criteria.
Notes	

SPINE LCI dataset: Waste treatment - incineration in heat only boiler plant (SWEA HOB)

Administrative	
Finished	Y
Date Completed	2013-03-18
Copyright	CPM LCA Database - free to use but not to resell the data
Availability	Public

Technical System	
Name	Waste treatment - incineration in heat only boiler plant (SWEA HOB)
Functional Unit	1 kg waste fraction to incineration in HOB plant
Functional Unit Explanation	Data for the several separate waste fractions are available (see Technical system description).
Process Type	Gate to grave
Site	Sweden
Sector	Waste treatment
Owner	Sweden
Technical system description	This dataset represents Swedish BAT conditions in the period 2007-2010 for incineration of waste in heat only boiler plants (HOB). It is a generic model applied to several waste fractions. The emissions from incineration are modeled for the incineration of the waste mix and further allocated to the specific waste fractions. Using data for incineration of only one specific fraction would not reflect the real situation, since the emission data for each fraction is valid in case of co-combustion with other fractions. Primary waste fractions: Animal waste from food industry (Animal), Paper and cardboard containers (Cardb), Corrugated cardboard (Corrb), Discarded equipment including mainly metals and small amounts of plastic and rubber. Modeled as "metal mixed" (Equip), Pulp (FibreRej), Food waste (Food), Glass container clear (GlaCl), Glass container coloured (GlaCol), Hazardous waste from households waste bags (Haz_h), Other industrial effluent sludges inorganic (IndSlNOrg), Chemical sludges and biosludges from industry 50%/50% (IndSlOrg), Concrete, stone, bricks, not recycable (InMix), Metal waste, excluding the metal scrap from manufacturing, excluding return cans. The mix is: Aluminium 5%, ferrous metals (steel) 90%, stainless steel 2%, other metals modeled as copper 3% (Metal), Mixed municipal solid waste, the fractions and their shares are given in the corresponding data set (mixed MSW), Newsprint, journals, and catalogues (Newspr), Sanitary products (diapers) and other combustible wood waste 24%/74% (OthComb_h), Paper and cardboard containers 14%, corrugated cardboard 30%, newsprint, journals and catalogues 42%, office paper 14% (Paper), Park and yard waste with high heating value (Park), Park and yard waste with low heating value (Park_h), Polyethylene, soft packaging (PE), PE 40%, PP 15%, PET 4%, PS 4%, PVC 11%, PUR 13%, PC 13% (Plastics), Plaster as bulky waste from households (Plastr), Polystyrene (PS), Fibre recycling reject (RecFibRej),

	Rubber (Rubber), Public sewage sludge - digested (SewSludge), Textile, production waste (Text), Vegetal waste from food processing (Vegetal), Wood excl. Transport pallets, excl. By-products e.g.reject from sawmill and tree felling, excl. Secondary wood waste from public recycling stations ÅVC (Wood) Secondary waste fractions: Reject from anaerobic digestion (Incineration HOB digrej) - (Animal, Foods, IndSludgeOrg, Manure, Vegetal) Reject from reactor composting (Incineration HOB reactor compost reject) - (Animal, Foods, Vegetal) Reject from windrow composting (Incineration HOB windrow compost reject) - (Manure, Park 1, Park 2, SewSludge) This model covers activities at the HOB plant. Waste collection (sorting and transporting) of incoming waste goods to the plant is not included. Output heat energy is considered as delivered onto local district heating grid. Energy losses after point of delivery on the grid are not included The amount of ash and sludge generated is stated but treatment of this secondary waste in e.g. landfills is not included. For the secondary treatment of ash and sludge see the corresponding type of treatment e.g. landfill. That is, process models need to be linked in series. Internal technical system considered: The data reflect Swedish HOB plants' average operations. The incineration furnace is assumed to be operating with a mix of all the waste fractions. Emissions and energy output are however provided for each specific waste fraction separately. Internal energy consumption at the plant is included. Internal material consumption at the plant (e.g. greasing, filter changes etc.) is not included. Consumption of process additives/chemicals (e.g. lime, ammonia, etc.) necessary for incineration (emissions reduction) is included. Construction of capital goods e.g. buildings and machinery at the waste treatment facility is not included. Auxiliary facilities and operations such as offices and work travel are not included.

System Boundaries

Nature Boundary	
Time Boundary	The modelled data is an approximation of BAT in Sweden in the period 2007-2010
Geographical Boundary	The model reflects the waste treatment system in Sweden.
Other Boundaries	See Technical system description
Allocations	As a base case, allocation is done on a material flow (mass) basis. That is, emissions are calculated in relation to the amount of a substance in each waste fraction. This is done for substances that are not transformed, where there is a mass balance. Other emissions are calculated in other ways depending on what was deemed the most relevant (allocated per MJ, or per total mass of the waste fraction). For landfill and incineration this is documented in Anna Björklund's licentiate thesis (Björklund A, 1998).
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Modeled data
Represents	Swedish BAT average operating conditions
Method	Inventory data was mainly collected from literature studies and results from previous related projects. Data has been remodeled to match the scope of SWEA. Some emission flow data were calculated with the ORWARE model (Björklund 1998; Eriksson et al. 2002).
Literature Reference	Download file with flows for all waste fractions at http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Björklund, A., Eriksson O., Ljunggren Söderman M., Stenmarck Å. and Sundqvist J-O (2009) "LCA of Policy Instruments for Sustainable Waste Management", Poster presentation, ISWA and Dakofa Conference Waste and Climate, Copenhagen, 2009. Björklund A, (1998), "Environmental systems analysis of waste management with emphasis on substance flows and environmental impact", Licentiate Thesis, Division of Industrial Ecology, Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden (ISSN 1402-7615, TRITA-KET-IM 1998:16, AFR-Report 211), 1998. Ekvall T, et al. (2006) "Towards Sustainable Waste Management - Programme plan", Project description, version 2006-04-09 as approved by Swedish EPA (Naturvårdsverket). Eriksson O, et al. (2002)

	"ORWARE - a simulation tool for waste management", Resources, Conservation and Recycling, Volume 36, Issue 4, November 2002, Pages 287-307. Ljunggren M (2000) "Modelling national solid waste management", Waste Management & Research 18:525-537, ISWA, December 2000 Östblom G, Berg C (2006) "The EMEC model: Version 2.0", Working Paper 96, National Institute of Economic Research, Stockholm, Sweden, 2006. Östblom G, (1999) "An Environmental Medium Term Economic Model EMEC", Working Paper 69, National Institute for Economic Research, Stockholm, Sweden, 1999.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported in the environmental report is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Waste	Waste	1			kg	Technosphere	Sweden

About Inventory

Publication	Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Flow data output for specific waste fractions from SWEA model : http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx
Intended User	LCA practitioners
General Purpose	Publication of data on Swedish waste treatement system
Detailed Purpose	See About data
Commissioner	Naturvårdsverket (Swedish EPA) - .
Practitioner	See About data - .
Reviewer	Tivander, Johan -
Applicability	For applicability for the process see 'Technical system description' and 'System Boundaries' above
About Data	This dataset is part of the Swedish Waste Management Environmental Assessment (SWEA) LCA model of the Swedish waste treatment system (Björklund et al. 2009; Arushanyan et al. 2013). The SWEA model covers several waste fractions and several waste treatments. It was developed in the Towards Sustainable Waste Management - TOSUWAMA (Hållbar Avfallshantering) research programme, funded by Swedish EPA (Naturvårdsverket) running 2006-2013 (Ekvall et al. 2006). The main contributors to the SWEA model: Ola Eriksson - Gävle University (HiG); Anna Björklund, Christine Ambell, Yevgeniya Arushanyan - Environmental Strategies Research, Royal Institute of Technology (FMS KTH); Jan-Olof Sundqvist, Åsa Stenmark, Maria Ljunggren Söderman - Swedish Environmental Institute (IVL) This dataset is part of several datasets from the SWEA model published in CPM LCA Database. The datasets are: Waste treatment - SWEA model - incineration in combined heat and power plant (CHP) Waste treatment - SWEA model - incineration in heat only boiler plant (HOB) Waste treatment - SWEA model - incineration for heat in cement kiln (CKN) Waste treatment - SWEA model - reactor composting (CPR) Waste treatment - SWEA model - windrow composting (CPW) Waste treatment - SWEA model - landfill (LFL) More information about the TOSUWAMA project is available at www.hallbaravfallshantering.se. This dataset was documented in the CPM LCA Database by Johan Tivander, Environmental Systems Analysis, Chalmers University of Technology, Sweden. Review by Johan Tivander considers CPM LCA Database documentation criteria.
Notes	

SPINE LCI dataset: Waste treatment - landfill (SWEA LFL)

Administrative	
Finished	Y
Date Completed	2013-03-18
Copyright	CPM LCA Database - free to use but not to resell the data
Availability	Public

Technical System	
Name	Waste treatment - landfill (SWEA LFL)
Functional Unit	1 kg waste fraction to landfill
Functional Unit Explanation	Data for the several separate waste fractions are available (see Technical system description).
Process Type	Gate to grave
Site	Sweden
Sector	Waste treatment
Owner	Sweden
Technical system description	This dataset represents Swedish BAT conditions in the period 2007-2012 for landfill of waste (LFL). It is a generic model applied to several waste fractions. The emissions are modelled for two time frames - surveyable time (100 years) (ST) and remaining time (hypothetical infinity) (RT). A surveyable period is the period until a pseudo steady-state in the landfill processes is obtained. This period is typically of the magnitude of one century. A hypothetical, infinite time period is the period from the start until the landfilled material is completely released to the environment. These time frames are presented in separate datasets: ST- surveyable time only including emissions from ST, RT - remaining time only including emissions from RT. To calculate total emissions over ST and RT, the two data sets need to be added. Primary waste fractions: Other chemical wastes and residues from households (e.g. medicines, mixed chemical waste) and industry (mainly pulp), non hazardous, inorganic. Modeled as green liquor (grönlutslam) because most of it comes from pulp (Chemical, Chemical RT), Glass container clear (Glass Clear, Glass Clear RT), Glass container coloured (Glass Color, GlassColor RT), Other industrial effluent sludges inorganic (IndSlNOrg, IndSlNOrg RT), Concrete, stone, bricks, not recycable (InMix, InMix RT), Other ashes from incineration, non-recyclable (OtherAshes, OtherAshes RT), Plaster as bulky waste from households (Plaster, Plaster RT), Steel slag from steel industry, non-recyclable (SlagNRec, SlagNRec RT), Steel slag from steel industry, recyclable (SlagRec, SlagRec RT), Sorting ashes (SortAsh RT), Wood flyashes - biofuel ashes (WoodFlAsh, WoodFlAsh RT) Secondary waste fractions: Landfilling of ash from the incineration in Cement Kiln (Ash landfill Cement kiln) - (Industrial sludge org, PE, plastics, PS, rubber, Untreated wood) Landfilling of ash from the incineration - CHP - of the anaerobic digestion reject (Ash landfill CHP Digester reject) - (Animal) Landfilling of ash from incineration - CHP or HOB (Ash landfill from Incineration, ST) - (Animal, Cardboard, Corrugated cardboard, Fibre Reject, Foods, Glass Clear, Glass Color, Hazardous-chemical has, IndSludgeNOrg, IndSludgeOrg, Inert mix, Metal, Newsprint, Other comb, Paper, Park, Park_h-low HHV, PE, PS, Reused Fibre Reject, Rubber, Textile, Vegetal, Wood Landfilling of ash from incineration - CHP or HOB - of windrow composting - CPW - reject (Ash landfill incineration CPW reject - Garden waste, Industrial sludge org, Manure, Park-garden waste, Sew sludge) Landfilling of ash from the incineration - CHP - of the anaerobic digestion reject (Slag landfill CHP Digester reject) - (Animal) Landfilling of slag from incineration - CHP or HOB, slag composition same from CHP and HOB (Slag landfill from Incineration) - (Animal, Cardboard, Corrugated cardboard, Fiber Reject, Foods, Glass clear, Glass Colorr, Hazardous-chemical has, IndSludgeNOrg, IndSludgeOrg, Inert mix, Metal, Newsprint, Other comb, Paper, Park-high HHV, Park_h-low HHV, PE, Plastics, PS, RecFiber Reject, Rubber, Textile, Vegetal , Wood) Landfilling of slag from incineration (CHP or HOB) of the windrow composing - CPW - reject (Slag landfill Incineration CPW reject - Garden waste, Industrial sludge org, Manure, Park-garden waste, Sew sludge) This model covers activities at the landfill. Waste collection (sorting and transporting) of

	incoming waste goods to the landfill is not included. For the waste fraction 'Inorganic industrial sludge' energy is recovered. Inorganic industrial sludge has been defined as containing 2.2 % cellulose (based on DM). There is 25 % water in this fraction. Cellulose is then degraded in the landfill producing landfill gas which is extracted and combusted giving heat and electricity and considered as avoided products. Internal technical system considered: The data reflect Swedish landfills' average operations. The landfill is assumed to be a mix of all the waste fractions. Inputs and outputs are however provided for each specific waste fraction separately. Internal energy consumption for operating the facility is included. Internal material consumption for operating the facility is not included. Construction of capital goods e.g. buildings and machinery at the waste treatment facility is not included. Auxiliary facilities and operations such as offices and work travel are not included.

System Boundaries

Nature Boundary	
Time Boundary	The modelled data is an approximation of BAT in Sweden in the period 2007-2010
Geographical Boundary	The model reflects the waste treatment system in Sweden.
Other Boundaries	See Technical system description
Allocations	As a base case, allocation is done on a material flow (mass) basis. That is, emissions are calculated in relation to the amount of a substance in each waste fraction. This is done for substances that are not transformed, where there is a mass balance. Other emissions are calculated in other ways depending on what was deemed the most relevant (allocated per MJ, or per total mass of the waste fraction). For landfill and incineration this is documented in Anna Björklund's licentiate thesis (Björklund A, 1998).
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Modeled data
Represents	Swedish BAT average operating conditions
Method	Inventory data was mainly collected from literature studies and results from previous related projects. Data has been remodeled to match the scope of SWEA. Some emission flow data were calculated with the ORWARE model (Björklund 1998; Eriksson et al. 2002).
Literature Reference	Download file with flows for all waste fractions at http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Björklund, A., Eriksson O., Ljunggren Söderman M., Stenmarck Å. and Sundqvist J-O (2009) "LCA of Policy Instruments for Sustainable Waste Management", Poster presentation, ISWA and Dakofa Conference Waste and Climate, Copenhagen, 2009. Björklund A, (1998), "Environmental systems analysis of waste management with emphasis on substance flows and environmental impact", Licentiate Thesis, Division of Industrial Ecology, Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden (ISSN 1402-7615, TRITA-KET-IM 1998:16, AFR-Report 211), 1998. Ekvall T, et al. (2006) "Towards Sustainable Waste Management - Programme plan", Project description, version 2006-04-09 as approved by Swedish EPA (Naturvårdsverket). Eriksson O, et al. (2002) "ORWARE - a simulation tool for waste management", Resources, Conservation and Recycling, Volume 36, Issue 4, November 2002, Pages 287-307. Ljunggren M (2000) "Modelling national solid waste management", Waste Management & Research 18:525-537, ISWA, December 2000 Östblom G, Berg C (2006) "The EMEC model: Version 2.0", Working Paper 96, National Institute of Economic Research, Stockholm, Sweden, 2006. Östblom G, (1999) "An Environmental Medium Term Economic Model EMEC", Working Paper 69, National Institute for Economic Research, Stockholm, Sweden, 1999.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported in the environmental report is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Waste	Waste	1			kg	Technosphere	Sweden

About Inventory

Publication	Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Flow data output for specific waste fractions from SWEA model : http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx
Intended User	LCA practitioners
General Purpose	Publication of data on Swedish waste treatement system
Detailed Purpose	See About data
Commissioner	Naturvårdsverket (Swedish EPA) - .
Practitioner	See About data - .
Reviewer	Tivander, Johan -
Applicability	For applicability for the process see 'Technical system description' and 'System Boundaries' above
About Data	This dataset is part of the Swedish Waste Management Environmental Assessment (SWEA) LCA model of the Swedish waste treatment system (Björklund et al. 2009; Arushanyan et al. 2013). The SWEA model covers several waste fractions and several waste treatments. It was developed in the Towards Sustainable Waste Management - TOSUWAMA (Hållbar Avfallshantering) research programme, funded by Swedish EPA (Naturvårdsverket) running 2006-2013 (Ekvall et al. 2006). The main contributors to the SWEA model: Ola Eriksson - Gävle University (HiG); Anna Björklund, Christine Ambell, Yevgeniya Arushanyan - Environmental Strategies Research, Royal Institute of Technology (FMS KTH); Jan-Olof Sundqvist, Åsa Stenmark, Maria Ljunggren Söderman - Swedish Environmental Institute (IVL) This dataset is part of several datasets from the SWEA model published in CPM LCA Database. The datasets are: Waste treatment - SWEA model - incineration in combined heat and power plant (CHP) Waste treatment - SWEA model - incineration in heat only boiler plant (HOB) Waste treatment - SWEA model - incineration for heat in cement kiln (CKN) Waste treatment - SWEA model - reactor composting (CPR) Waste treatment - SWEA model - windrow composting (CPW) Waste treatment - SWEA model - landfill (LFL) More information about the TOSUWAMA project is available at www.hallbaravfallshantering.se. This dataset was documented in the CPM LCA Database by Johan Tivander, Environmental Systems Analysis, Chalmers University of Technology, Sweden. Review by Johan Tivander considers CPM LCA Database documentation criteria.
Notes	

SPINE LCI dataset: Waste treatment - reactor composting (SWEA CPR)

Administrative	
Finished	Y
Date Completed	2013-03-18
Copyright	CPM LCA Database - free to use but not to resell the data
Availability	Public

Technical System	
Name	Waste treatment - reactor composting (SWEA CPR)
Functional Unit	1 kg waste fraction to reactor composting

Functional Unit Explanation	Data for the several separate waste fractions are available (see Technical system description).
Process Type	Gate to grave
Site	Sweden
Sector	Waste treatment
Owner	Sweden
Technical system description	This dataset represents Swedish BAT conditions in the period 2007-2010 for reactor composting of waste (CPR). It is a generic model applied to several waste fractions: Animal waste from food industry (Animal), Food waste (Food), Park and yard waste with low heating value (Park_h), Vegetal waste from food processing (Vegetal) This model covers activities at the reactor composting facility. Waste collection (sorting and transporting) of incoming waste goods to the plant is not included. Heat energy generated is used for district heating and hence considered as avoided heat production. Compost is generated as a waste treatment product; reject from CPR is generated as secondary waste. Further usage of the compost product in soil manufacture and secondary waste treatment of the reject (incineration in CHP plant) are not included. For the processes of compost use and incineration of the reject in CHP plant see corresponding data sets. That is, process models need to be linked in series. Internal technical system considered: The data reflect Swedish CPR facilities' average operations. The compost reactor is assumed to be operating with a mix of all the waste fractions. Emissions and energy output are however provided for each specific waste fraction separately. Internal electricity and fuel consumption for operating the facility is included. Internal material consumption for operating the facility is not included. Construction of capital goods e.g. buildings and machinery at the waste treatment facility is not included. Auxiliary facilities and operations such as offices and work travel are not included.

System Boundaries

Nature Boundary	
Time Boundary	The modelled data is an approximation of BAT in Sweden in the period 2007-2010
Geographical Boundary	The model reflects the waste treatment system in Sweden.
Other Boundaries	See Technical system description
Allocations	As a base case, allocation is done on a material flow (mass) basis. That is, emissions are calculated in relation to the amount of a substance in each waste fraction. This is done for substances that are not transformed, where there is a mass balance. Other emissions are calculated in other ways depending on what was deemed the most relevant (allocated per MJ, or per total mass of the waste fraction). For landfill and incineration this is documented in Anna Björklund's licentiate thesis (Björklund A, 1998).
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	2010
Data Type	Modeled data
Represents	Swedish BAT average operating conditions
Method	Inventory data was mainly collected from literature studies and results from previous related projects. Data has been remodeled to match the scope of SWEA. Some emission flow data were calculated with the ORWARE model (Björklund 1998; Eriksson et al. 2002).
Literature Reference	Download file with flows for all waste fractions at http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Björklund, A., Eriksson O., Ljunggren Söderman M., Stenmarck Å. and Sundqvist J-O (2009) "LCA of Policy Instruments for Sustainable Waste Management", Poster presentation, ISWA and Dakofa Conference Waste and Climate, Copenhagen, 2009. Björklund A, (1998), "Environmental systems analysis of waste management with emphasis on substance flows and environmental impact", Licentiate Thesis, Division of Industrial Ecology, Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden (ISSN 1402-7615, TRITA-KET-IM 1998:16, AFR-Report 211), 1998. Ekvall T, et al. (2006)

	"Towards Sustainable Waste Management - Programme plan", Project description, version 2006-04-09 as approved by Swedish EPA (Naturvårdsverket). Eriksson O, et al. (2002) "ORWARE - a simulation tool for waste management", Resources, Conservation and Recycling, Volume 36, Issue 4, November 2002, Pages 287-307. Ljunggren M (2000) "Modelling national solid waste management", Waste Management & Research 18:525-537, ISWA, December 2000 Östblom G, Berg C (2006) "The EMEC model: Version 2.0", Working Paper 96, National Institute of Economic Research, Stockholm, Sweden, 2006. Östblom G, (1999) "An Environmental Medium Term Economic Model EMEC", Working Paper 69, National Institute for Economic Research, Stockholm, Sweden, 1999.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported in the environmental report is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Waste	Waste	1			kg	Technosphere	Sweden

About Inventory

Publication	Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Flow data output for specific waste fractions from SWEA model : http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx
Intended User	LCA practitioners
General Purpose	Publication of data on Swedish waste treatement system
Detailed Purpose	See About data
Commissioner	Naturvårdsverket (Swedish EPA) - .
Practitioner	See About data - .
Reviewer	Tivander, Johan -
Applicability	For applicability for the process see 'Technical system description' and 'System Boundaries' above
About Data	This dataset is part of the Swedish Waste Management Environmental Assessment (SWEA) LCA model of the Swedish waste treatment system (Björklund et al. 2009; Arushanyan et al. 2013). The SWEA model covers several waste fractions and several waste treatments. It was developed in the Towards Sustainable Waste Management - TOSUWAMA (Hållbar Avfallshantering) research programme, funded by Swedish EPA (Naturvårdsverket) running 2006-2013 (Ekvall et al. 2006). The main contributors to the SWEA model: Ola Eriksson - Gävle University (HiG); Anna Björklund, Christine Ambell, Yevgeniya Arushanyan - Environmental Strategies Research, Royal Institute of Technology (FMS KTH); Jan-Olof Sundqvist, Åsa Stenmark, Maria Ljunggren Söderman - Swedish Environmental Institute (IVL) This dataset is part of several datasets from the SWEA model published in CPM LCA Database. The datasets are: Waste treatment - SWEA model - incineration in combined heat and power plant (CHP) Waste treatment - SWEA model - incineration in heat only boiler plant (HOB) Waste treatment - SWEA model - incineration for heat in cement kiln (CKN) Waste treatment - SWEA model - reactor composting (CPR) Waste treatment - SWEA model - windrow composting (CPW) Waste treatment - SWEA model - landfill (LFL) More information about the TOSUWAMA project is available at www.hallbaravfallshantering.se. This dataset was documented in the CPM LCA Database by Johan Tivander, Environmental Systems Analysis, Chalmers University of Technology, Sweden. Review by Johan Tivander considers CPM LCA Database documentation criteria.
Notes	

SPINE LCI dataset: Waste treatment - windrow composting (SWEA CPW)

Administrative	
Finished	Y
Date Completed	2013-03-18
Copyright	CPM LCA Database - free to use but not to resell the data
Availability	Public

Technical System	
Name	Waste treatment - windrow composting (SWEA CPW)
Functional Unit	1 kg waste fraction to windrow composting
Functional Unit Explanation	Data for the several separate waste fractions are available (see Technical system description).
Process Type	Gate to grave
Site	Sweden
Sector	Waste treatment
Owner	Sweden
Technical system description	This dataset represents Swedish BAT conditions in the period 2007-2010 for windrow composting of waste (CPW). It is a generic model applied to several waste fractions: Chemical sludges and biosludges from industry 50%/50% (IndSlOrg), Manure, excluding the one used in the gardens (Manure), Park and yard waste with high heating value (Park), Public sewage sludge - digested (SewSludge) This model covers activities at the windrow composting facility. Waste collection (sorting and transporting) of incoming waste goods to the plant is not included. Compost is generated as a waste treatment product; reject from CPW is generated as secondary waste. Further usage of the compost product in soil manufacture and secondary waste treatment of the reject (incineration in CHP plant) are not included. For the processes of compost use and incineration of the reject in CHP plant see corresponding data sets. That is, process models need to be linked in series. Internal technical system considered: The data reflect Swedish CPW facilities' average operations. The windrow compost is assumed to be operating with a mix of all the waste fractions. Emissions and product output are however provided for each specific waste fraction separately. Internal electricity and fuel consumption for operating the facility is included. Internal material consumption for operating the facility is not included. Construction of capital goods e.g. buildings and machinery at the waste treatment facility is not included. Auxiliary facilities and operations such as offices and work travel are not included.

System Boundaries	
Nature Boundary	
Time Boundary	The modelled data is an approximation of BAT in Sweden in the period 2007-2010
Geographical Boundary	The model reflects the waste treatment system in Sweden.
Other Boundaries	See Technical system description
Allocations	As a base case, allocation is done on a material flow (mass) basis. That is, emissions are calculated in relation to the amount of a substance in each waste fraction. This is done for substances that are not transformed, where there is a mass balance. Other emissions are calculated in other ways depending on what was deemed the most relevant (allocated per MJ, or per total mass of the waste fraction). For landfill and incineration this is documented in Anna Björklund's licentiate thesis (Björklund A, 1998).
Systems Expansions	N/A

Flow Data
General Activity QMetaData

Date Conceived	2010
Data Type	Modeled data
Represents	Swedish BAT average operating conditions
Method	Inventory data was mainly collected from literature studies and results from previous related projects. Data has been remodeled to match the scope of SWEA. Some emission flow data were calculated with the ORWARE model (Björklund 1998; Eriksson et al. 2002).
Literature Reference	Download file with flows for all waste fractions at http://cpmdatabase.cpm.chalmers.se /DataReferences/SWEA LCI process data.xlsx Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Björklund, A., Eriksson O., Ljunggren Söderman M., Stenmarck Å. and Sundqvist J-O (2009) "LCA of Policy Instruments for Sustainable Waste Management", Poster presentation, ISWA and Dakofa Conference Waste and Climate, Copenhagen, 2009. Björklund A, (1998), "Environmental systems analysis of waste management with emphasis on substance flows and environmental impact", Licentiate Thesis, Division of Industrial Ecology, Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden (ISSN 1402-7615, TRITA-KET-IM 1998:16, AFR-Report 211), 1998. Ekvall T, et al. (2006) "Towards Sustainable Waste Management - Programme plan", Project description, version 2006-04-09 as approved by Swedish EPA (Naturvårdsverket). Eriksson O, et al. (2002) "ORWARE - a simulation tool for waste management", Resources, Conservation and Recycling, Volume 36, Issue 4, November 2002, Pages 287-307. Ljunggren M (2000) "Modelling national solid waste management", Waste Management & Research 18:525-537, ISWA, December 2000 Östblom G, Berg C (2006) "The EMEC model: Version 2.0", Working Paper 96, National Institute of Economic Research, Stockholm, Sweden, 2006. Östblom G, (1999) "An Environmental Medium Term Economic Model EMEC", Working Paper 69, National Institute for Economic Research, Stockholm, Sweden, 1999.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported in the environmental report is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Waste	Waste	1			kg	Technosphere	Sweden

About Inventory

Publication	Arushanyan Y , Björklund A, Eriksson O, Finnveden G, Ljunggren Söderman M, Stenmarck Å. Sundqvist J-O (2013) "Environmental assessment of possible future waste management scenarios", article in preparation. Flow data output for specific waste fractions from SWEA model : http://cpmdatabase.cpm.chalmers.se/DataReferences/SWEA LCI process data.xlsx
Intended User	LCA practitioners
General Purpose	Publication of data on Swedish waste treatement system
Detailed Purpose	See About data
Commissioner	Naturvårdsverket (Swedish EPA) - .
Practitioner	See About data - .
Reviewer	Tivander, Johan -
Applicability	For applicability for the process see 'Technical system description' and 'System Boundaries' above
About Data	This dataset is part of the Swedish Waste Management Environmental Assessment (SWEA) LCA model of the Swedish waste treatment system (Björklund et al. 2009; Arushanyan et al. 2013). The SWEA model covers several waste fractions and several waste treatments. It was developed in the Towards Sustainable Waste Management - TOSUWAMA (Hållbar Avfallshantering) research programme, funded by Swedish EPA (Naturvårdsverket) running 2006-2013 (Ekvall et al. 2006). The main contributors to the SWEA model: Ola Eriksson - Gävle University (HiG); Anna Björklund, Christine Ambell, Yevgeniya Arushanyan - Environmental Strategies Research, Royal Institute of Technology (FMS KTH); Jan-Olof Sundqvist, Åsa Stenmark, Maria Ljunggren Söderman - Swedish Environmental Institute (IVL) This dataset is part of several datasets from the SWEA model published in CPM LCA Database. The datasets are: Waste treatment - SWEA model - incineration in combined heat and power plant (CHP) Waste treatment - SWEA model - incineration in heat only boiler plant (HOB) Waste treatment - SWEA model - incineration for heat in cement kiln (CKN)

	Waste treatment - SWEA model - reactor composting (CPR) Waste treatment - SWEA model - windrow composting (CPW) Waste treatment - SWEA model - landfill (LFL) More information about the TOSUWAMA project is available at www.hallbaravfallshantering.se. This dataset was documented in the CPM LCA Database by Johan Tivander, Environmental Systems Analysis, Chalmers University of Technology, Sweden. Review by Johan Tivander considers CPM LCA Database documentation criteria.
Notes	

SPINE LCI dataset: Vattenfall electricity production system

Administrative	
Finished	Y
Date Completed	1996-12-01
Copyright	
Availability	Public

Technical System	
Name	Vattenfall electricity production system
Functional Unit	1 kWh
Functional Unit Explanation	Production of 1 kWh electricity
Process Type	Other
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	The electricity production system of Vattenfall consists of a large number of power plants based on different technique and with very different environmental impact. The system is a combination of base, control and peak power where the different power sources complement each other. Nuclear and hydropower is the base for the system of Vattenfall. Hydropower is also used for control power. When the control possibilities of the water power are not sufficient, other power sources are used in the following order: nuclear power, combined heat and power, import, oil condensing power and oil fired gas turbine power. Combined heat and power is used as base, principally during the winter half, when the need for both heat and power are the largest. Oil fired condensing plants is used for seasonal and long-term needs for reserve power. Gas turbine power plants are primarily reserve power for very short term needs.

System Boundaries	
Nature Boundary	
Time Boundary	The data is fairly representative of the electricity production of Vattenfall AB over the last 10-15 years.
Geographical Boundary	The electricity is produced in Sweden.
Other Boundaries	
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	Unspecified
Represents	Swedish BAT average operating conditions
Method	The share of the different power sources of the total electricity production have been calculated by dividing the total electricity production of each power source with the total electricity production by Vattenfall AB during 1995. The total electricity production in the power plants of Vattenfall AB were 75 718 GWh. The data can be found in Brännström-Norberg B-M et.al.
Literature Reference	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB
Notes	The power sources that produce the different shares of electricity can be found under Notes for each specific flow into the system.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Electricity produced by combined heat and power, fired by oil	Input	Refined resource	Electricity	.000040			kWh	Technosphere	
Notes: Electricity produced by gas turbine power	Input	Refined resource	Electricity	.000040			kWh	Technosphere	
Notes: Electricity produced by combined heat and power, fired by natural gas	Input	Refined resource	Electricity	.000119			kWh	Technosphere	
Notes: Electricity produced by combined heat and power, fired by coal	Input	Refined resource	Electricity	.000132			kWh	Technosphere	
Notes: Electricity produced by wind power	Input	Refined resource	Electricity	.000145			kWh	Technosphere	
Notes: Electricity produced by oil condensing power	Input	Refined resource	Electricity	.000145			kWh	Technosphere	
Notes: Electricity produced by combined heat and power, fired by bio fuel	Input	Refined resource	Electricity	.000647			kWh	Technosphere	
Notes: Electricity produced by combined heat and power, fired by peat	Input	Refined resource	Electricity	.000859			kWh	Technosphere	
Notes: Electricity produced by hydropower	Input	Refined resource	Electricity	.465505			kWh	Technosphere	
Notes: Electricity produced by nuclear power	Input	Refined resource	Electricity	.532514			kWh	Technosphere	
	Output	Product	Electricity	1			kWh	Technosphere	

About Inventory

Publication	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology
Intended User	
General Purpose	
Detailed Purpose	To calculate the total environmental impact of the electricity production system of Vattenfall AB, using life cycle analysis of the different power sources.
Commissioner	- Vattenfall Elproduktion .
Practitioner	- Vattenfall Energisystem AB: Britt-Marie Brännström-Norberg Ulrika Dethlefsen Roland Johansson Caroline Setterwall Sofie Tunbrant .
Reviewer	- Thomas Ekvall, Chalmers Industriteknik (CIT) Gunnar Lindfors, Institutet för Vatten- och Luftvårdsforskning (IVL) Göran Finnveden, Institutet för Vatten- och Luftvårdsforskning (IVL)
Applicability	The data represents the electricity production of Vattenfall in 1995, which is a fairly representative year. The share of the different power sources varies from year to year, depending on primarily the supply of hydropower. Since 10-15 years, almost all of the electricity has been produced by hydropower and nuclear power. The share of fossil power has been low. The following data can be used to calculate the environmental impact of the electricity production system: *Hydropower* - data for hydropower in Brännström-Norberg B-M et al.

	Nuclear power - data for nuclear power in Brännström-Norberg B-M et al. *Combined heat and power, bio fuel* - data for the combined heat and power fired with wood fuel in Brännström-Norberg B-M et al. can be used. *Combined heat and power, coal* - data for fuel production and operation of the power plant can be found in Brännström-Norberg, Rosén-Lidholm et al. ''Analys av miljökonsekvenser för ett kraftvärmeverk eldat med salix - jämförelse med miljökonsekvenserna för kol och skogbränsle'' Vattenfall Utveckling AB, Projekt Bioenergi 1994/3 *Combined heat and power, peat* - data for the fuel production of wood fuel (in the analysis of Combined heat and power, bio fuel) in Brännström-Norberg B-M. et al. can be used. For the operation of the plant, the environmental report of ''Uppsala energi'' can be used. *Combined heat and power, natural gas* - data for fuel production and operation of the power plant can be extrapolated from the data for a natural gas fired combination plant in Brännström-Norberg B-M et al. *Combined heat and power, oil* - data for the fuel production can be found in the analysis for the oil condensing power plant in Brännström-Norberg B-M et al. *Oil condensing power* - data for an oil condensing plant can be found in Brännström-Norberg B-M et al. *Gas turbine power* - data for a gas turbine power plant can be found in Brännström-Norberg B-M. et al. *Wind power* - data for a wind power plant can be found in Brännström-Norberg B-M. et al.
About Data	
Notes	

SPINE LCI dataset: Vessel Göteborg to Halmstad

Administrative	
Finished	Y
Date Completed	1999-04-20
Copyright	
Availability	public

Technical System	
Name	Vessel Göteborg to Halmstad
Functional Unit	14 394 m3 pre-treated waste oil transported from Göteborg to Halmstad.
Functional Unit Explanation	The vessel is half loaded when carrying out the transports. The calculation of the emissions are based on the known specific fuel consumption.
Process Type	Gate to gate
Site	
Sector	Sea transport
Owner	

Technical system description	The transportation of pre-treated waste oil from Göteborg to Halmstad, 140 km. The density for the waste oil is 0,93 ton / m3 due to the water pollution. The total amount of waste oil transported during 1997 was 14 394 m3. The transportation step consumes fuel oil and releases emissions to the system environment. The ship size is below 2000 dwt and the transports are assumed to be carried out half loaded. The transportation step consumes fuel and releases emissions to the system environment.

System Boundaries

Nature Boundary	Only emissions legeslated by law is represented by NTM.
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary is set to Sweden.
Other Boundaries	The loading and unloading steps are neglected in terms of resource use and emissions. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. It is assumed the there occurs no spill.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998-12-29
Data Type	Derived, unspecified
Represents	Swedish BAT average operating conditions
Method	NTM presents data about emissions that are released for vessels (< 2000 dwt, half loaded with cargo) that consumes 8,8 g fuel / tonkm. The vessel that is employed by Reci however consumes 7,6 g fuel/ tonkm (Bengt Borg) i.e. 85,9 per cent of the presented data. Therefore the calculations anticipate that the emissions are 14,1 per cent smaller. NOx, HC, PM, CO, CO2 and SO2 are presented in grams released per tonkm (NTM). The density for fuel is 0,89 kg / litre and 4,45 kWh / litre fuel. (NTM). The transportation of pre-treated waste oil from Göteborg to Halmstad, 140 km. The density for the waste oil is 0,93 ton / m3 due to the water pollution. The total amount of waste oil transported during 1997 was 14 394 m3.
Literature Reference	http://www.ntm.a.se/emissioner/ship/data/lastfartyg_mindre.htm, last uppdated 1998-09-08 Bengt Borg, Production Manager, Reci Industri AB in Halmstad
Notes	The power sources that produce the different shares of electricity can be found under Notes for each specific flow into the system.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Cargo	Waste oil	14394			m3	Technosphere	
	Input	Refined resource	Heavy oil	1468			kg	Technosphere	Sweden
	Output	Cargo	Waste oil	14394			m3	Technosphere	
	Output	Emission	CO	75			kg	Air	Sweden
Literature:	Output	Emission	CO2	48914			kg	Air	Sweden
	Output	Emission	HC	18.7			kg	Air	Sweden
	Output	Emission	NOx	1162			kg	Air	Sweden
	Output	Emission	Particles	37.5			kg	Air	Sweden
	Output	Emission	SO2	825			kg	Air	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik Technical Environmental Planning, Chalmers University of Technology
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result is used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000

	certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emission released from the vessel during transportation.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are specific for coastal transportations that are carried out for Reci by smaller vessels (2000 DWT)
About Data	If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Vessel Halmstad to Slite

Administrative	
Finished	Y
Date Completed	1999-04-20
Copyright	
Availability	public

Technical System	
Name	Vessel Halmstad to Slite
Functional Unit	36604 m3 of converted fuel oil transported from Halmstad to Slite
Functional Unit Explanation	The vessel is half loaded when carrying out the transports. The calculation of the emissions are based on the known specific fuel consumption.
Process Type	Gate to gate
Site	
Sector	Sea transport
Owner	
Technical system description	The transportation of converted fuel oil fromHalmstad to Slite, 420 km. The density for the converted fuel oil is 0,9 ton / m3. 36604 m3 was transported during 1997. The transportation step consumes fuel oil and releases emissions to the system environment. The ship size is below 2000 dwt and the transports are assumed to be carried out half loaded. The transportation step consumes fuel and releases emissions to the system environment.

System Boundaries	
Nature Boundary	Only emissions legeslated by law is represented by NTM.
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary is set to Sweden.

Other Boundaries	The loading and unloading steps are neglected in terms of resource use and emissions. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. It is assumed the there occurs no spill.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998-12-29
Data Type	Derived, unspecified
Represents	Swedish BAT average operating conditions
Method	NTM presents data about emissions that are released for vessels (< 2000 dwt, half loaded with cargo) that consumes 8,8 g fuel / tonkm. The vessel that is employed by Reci however consumes 7,6 g fuel/ tonkm (Bengt Borg) i.e. 85,9 per cent of the presented data. Therefore the calculations anticipate that the emissions are 14,1 per cent smaller. NOx, HC, PM, CO, CO2 and SO2 are presented in grams released per tonkm (NTM). The density for fuel is 0,89 kg / litre and 4,45 kWh / litre fuel. (NTM). The transportation of converted fuel oil fromHalmstad to Slite, 420 km. The density for the converted fuel oil is 0,9 ton / m3. 35485 m3 was transported during 1997.
Literature Reference	http://www.ntm.a.se/emissioner/ship/data/lastfartyg_mindre.htm, last uppdated 1998-09-08 Bengt Borg, Production Manager, Reci Industri AB in Halmstad
Notes	The power sources that produce the different shares of electricity can be found under Notes for each specific flow into the system.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
	Input	Cargo	Converted fuel oil	36604			m3	Technosphere	
	Input	Refined resource	Heavy oil	104603			kg	Technosphere	Sweden
	Output	Cargo	Converted fuel oil	36604			m3	Technosphere	
	Output	Emission	CO	553			kg	Air	Sweden
Literature:	Output	Emission	CO2	361128			kg	Air	Sweden
	Output	Emission	HC	138			kg	Air	Sweden
	Output	Emission	NOx	8579			kg	Air	Sweden
	Output	Emission	Particles	227			kg	Air	Sweden
	Output	Emission	SO2	6088			kg	Air	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology -- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology --
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result is used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000 certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emission released from the vessel during transportation.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden

Applicability	The data are specific for coastal transportations that are carried out for Reci by smaller vessels (2000 DWT)
About Data	If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Vessel Loudden to Halmstad

Administrative	
Finished	Y
Date Completed	1999-04-20
Copyright	
Availability	public

Technical System	
Name	Vessel Loudden to Halmstad
Functional Unit	19 554 m3 of waste oil transported from Loudden to Halmstad
Functional Unit Explanation	Tthe vessel is half loaded when carrying out the transports. The calculation of the emissions are based on the known specific fuel consumption.
Process Type	Gate to gate
Site	
Sector	Sea transport
Owner	
Technical system description	The transportation of waste oil from Loudden to Halmstad, 520 km. The density for the waste oil is 0,93 ton / m3 due to the water pollution. 19 554 m3 of waste oil was transported during 1997 from Stockholm (Loudden) to Halmstad The transportation step consumes fuel oil and releases emissions to the system environment. The ship size is below 2000 dwt and the transports are assumed to be carried out half loaded. The transportation step consumes fuel and releases emissions to the system environment.

System Boundaries	
Nature Boundary	Only emissions legeslated by law is represented by NTM.
Time Boundary	The study only deals with retrospective data and no attempts are made to predict future events or conditions. 1997 is assumed as a suitable time frame to collect and interpret data.
Geographical Boundary	The geographical boundary is set to Sweden.
Other Boundaries	The loading and unloading steps are neglected in terms of resource use and emissions. The environmental impact from capital goods and activities serving the process are neglected e.g. personell, infrastructure and facilities. Moreover, maintenance and wear down of the system are neglected. It is assumed the there occurs no spill.
Allocations	
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1998-12-29
Data Type	Derived, unspecified
Represents	Swedish BAT average operating conditions
Method	NTM presents data about emissions that are released for vessels (< 2000 dwt, half loaded with cargo) that consumes 8,8 g fuel / tonkm. The vessel that is employed by Reci however consumes 7,6 g fuel/ tonkm (Bengt Borg) i.e. 85,9 per cent of the presented data. Therefore the calculations anticipate that the emissions are 14,1 per cent smaller. NOx, HC, PM, CO, CO2 and SO2 are presented in grams released per tonkm (NTM). The density for fuel is 0,89 kg / litre and 4,45 kWh / litre fuel. (NTM). The transportation of waste oil from Loudden to Halmstad, 520 km. The density for the waste oil is 0,93 ton / m3 due to the water pollution. 19 554 m3 of waste oil was transported during 1997 from Stockholm (Loudden) to Halmstad.
Literature Reference	http://www.ntm.a.se/emissioner/ship/data/lastfartyg_mindre.htm, last uppdated 1998-09-08 Bengt Borg, Production Manager, Reci Industri AB in Halmstad
Notes	The power sources that produce the different shares of electricity can be found under Notes for each specific flow into the system.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Cargo	Waste oil	19554			m3	Technosphere	
	Input	Refined resource	Heavy oil	71490			kg	Technosphere	Sweden
	Output	Cargo	Waste oil	19554			m3	Technosphere	
	Output	Emission	CO	378			kg	Air	Sweden
Literature:	Output	Emission	CO2	246810			kg	Air	Sweden
	Output	Emission	HC	94.6			kg	Air	Sweden
	Output	Emission	NOx	5863			kg	Air	Sweden
	Output	Emission	Particles	189			kg	Air	Sweden
	Output	Emission	SO2	4161			kg	Air	Sweden

About Inventory

Publication	Master thesis: ''LCA on converted fuel oil'' by Daniel Strandberg and Christer Wik, MSc students Technical environmental planning, Chalmers Univeristy of Technology --- Data documented by: Daniel Strandberg and Christer Wik, MSc students, Technical Environmental Planning, Chalmers University of Technology Documentation reviewed and classified by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology ---
Intended User	Internal use at Reci Industri
General Purpose	The objective of this study was to carry out a Life Cycle Assessment for converted fuel oil. The analysis involves outlining the environmental hazardous steps in the production. The result is used internally to aid as an environmental improving guidance as well as to receive a better view of the process. Externally, the result is a part of the Reci's ISO 14 000 certification which acts a guarantee to the costumes. The quality of the inquiry is set due the standards of a Master of Science thesis.
Detailed Purpose	To estimate the resource use and emission released from the vessel during transportation.
Commissioner	Schaff, Lars, environmental manager - Reci Industri AB Box 48047 418 21 Göteborg Sweden.
Practitioner	Strandberg, Daniel and Christer Wik - MSc students Technical Environmental Planning Chalmers University of Technology 41296 Göteborg Sweden.
Reviewer	Beckman, Torsten - Technical environmental planning Chalmers University of Technology 412 96 Göteborg Sweden
Applicability	The data are specific for coastal transportations that are carried out for Reci by smaller vessels (2000 DWT)
About Data	If data is utilised from this thesis it should be conducted with prudence. For receiving a more sufficient result for another activity, measurement should be utilised for each specific item in the production chain. However, the data represented in this study is of sufficient quality for being conducted when benchmarking.
Notes	The reviewer acted as supervisor for the Master thesis: ''LCA on converted fuel oil''

SPINE LCI dataset: Wheat cultivation. ESA-DBP

Administrative	
Finished	Y
Date Completed	2005
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System	
Name	Wheat cultivation. ESA-DBP
Functional Unit	1 kg of wheat
Functional Unit Explanation	1 kg of wheat on the yield where 3400kg/ha can be cultivated
Process Type	Gate to gate
Site	Unknown
Sector	Crop and animal production, hunting etc.
Owner	Unknown
Technical system description	The wheat cultivation was investigated in the study, because (excerpt from the report, see 'Publication') ''it has been shown that using peas as a precursor crop to winter wheat can increase the yield of winter wheat substantially, from about 6 000 kg/ha to 7 000 kg/ha. (...) However, it is not recommended that peas are cultivated more often than every seventh or eighth year, in order not to ruin the benefits achieved from crop rotation. In this study we assume that the extra wheat generated replaces cultivation of winter wheat in a cereal crop rotation. Apart from increasing the yield, peas can also reduce the need for pesticides in the subsequent crop. This process is included in the system described in: Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf Other processes in the CPM Database also included in the above publication: - Sausage (Soy-Dog) production. ESA-DBP - Sausage (Pea-Dog) production. ESA-DBP - Sausage (Hot-Dog) production. ESA-DBP - Operation of 'Hot Dogs' producing facility. ESA-DBP - Pea cultivation. ESA-DBP - Production of beef. ESA-DBP - Production of pork. ESA-DBP - Rape seed cultivation. ESA-DBP - Sugar beet cultivation. ESA-DBP - Soy bean processing. ESA-DBP - Soy bean cultivation. ESA-DBP

System Boundaries	
Nature Boundary	Data include use of energy, as well as emissions to air and water.
Time Boundary	Data were acquired in 2004 as the most up-to-date ones..
Geographical Boundary	The study was done for Sweden.
Other Boundaries	Excerpt from the report, see 'Publication': ''Not included are any aspects regarding personnel. (...) Pesticides, fungicides and herbicides are only taken into account quantitatively in the inventory section in this study (when data have been available), but are not analysed further in the results section. (...) some ingredients in the food processes have been judged to contribute very little to the overall process, and have therefore been excluded.

Allocations	No information about the allocation in the report.
Systems Expansions	Not applicable

Flow Data

General Activity QMetaData

Date Conceived	2004
Data Type	Derived, unspecified
Represents	See 'Function'
Method	Adapted from other report.
Literature Reference	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2005--10.pdf The particular data come from: Cederberg, C. & Flysjö, A. (2004). Environmental Assessment of Future Pig Farming Systems - Quantification of Three Scenarios from the FOOD 21 Synthesis Work. SIK report no.723. Swedish Institute of Food and Biotechnology (SIK), Gothenburg, Sweden
Notes	The power sources that produce the different shares of electricity can be found under Notes for each specific flow into the system.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
	Input	Refined resource	Electricity	2.50E+00			MJ	Technosphere	Sweden
	Input	Refined resource	Oil	3.50E+00			MJ	Technosphere	Sweden
	Output	Emission	CH4	6.00E-01			g	Air	Sweden
	Output	Emission	CO2	5.60E+02			g	Air	Sweden
	Output	Emission	N2O	1.20E+00			g	Air	Sweden
	Output	Emission	NH3	1.50E+00			g	Air	Sweden
	Output	Emission	NOx	1.00E-01			g	Air	Sweden
	Output	Emission	N-tot	3.10E+00			g	Water	Sweden
	Output	Emission	P-tot	6.40E+00			g	Water	Sweden
	Output	Product	Wheat	1.00E+03			g	Other	Sweden

About Inventory

Publication	Abelmann A. (2005). Environmental Potential of Increased Human Consumption of Grain Legumes. An LCA of food products. Master thesis. ESA report 2005:10, ISSN: 1404-8167. Chalmers University of Technology. Gothenburg, Sweden. Link to PDF: http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2005--10.pdf
Intended User	LCA practitioner
General Purpose	Excerpt from the report, see 'Publication': ''The overall aim of the study is to assess the potential environmental impacts of substituting animal protein for regionally grown vegetable protein in food products.''
Detailed Purpose	Excerpt from the report, see 'Publication': ''The objective is to analyze three food products of the same type, and the purpose is to compare the environmental impact of the products and also to identify the most important contributors of the total environmental impact of each product. The products are described as follows. - a product in which all protein is animal protein. - a product in which 10% of the animal protein is replaced with vegetable protein. - a product in which all protein is vegetable protein. Furthermore, the objective is to provide useful information on the products that can be used in other environmental systems analysis, e.g. in meal studies.
Commissioner	Swedish Institute of Food and Biotechnology (SIK AB), Sweden - .
Practitioner	Anders Abelmann - Chalmers University of Technology.
Reviewer	Jennifer Davis, Ulf Sonesson, - Swedish Institute of Food and Biotechnology (SIK AB); Björn Sandén (Chalmers University of Technology)
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above
About Data	ESA database project. Years 2009-2011. Administrating organization: Chalmers University of Technology, Department of Environmental Systems Analysis.

	Financier: The Swedish Research Council (Vetenskapsrådet) Data documentor: Katarzyna Iwanek assisted by Filippa Fuhrman (ESA) and Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material Systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The data for pea cultivation was taken from: Cederberg, C. & Flysjö, A. (2004). Environmental Assessment of Future Pig Farming Systems - Quantification of Three Scenarios from the FOOD 21 Synthesis Work. SIK report no.723. Swedish Institute of Food and Biotechnology (SIK), Gothenburg, Sweden

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SPINE LCI dataset: Wind electricity energy system, EPD-version

Administrative	
Finished	Y
Date Completed	1996-10
Copyright	Bundesamt für Energie, Bern
Availability	Public

Technical System	
Name	Wind electricity energy system, EPD-version
Functional Unit	1 TJ net electricity from power plant
Functional Unit Explanation	The generation of 1 TJ (1 000 000 000 000 J) net electricity (i.e. electricity need in the power plant has been supplied for by the plant itself). Electricity distribution and distribution losses are not accounted for, i.e. not for this particular unit process. Data about distribution and its losses may however be found in the original study.
Process Type	Cradle to grave
Site	Switzerland
Sector	Grid electricity and district heat
Owner	Switzerland
Technical system description	Reported figures are based on data from a LCI-study performed at ETH, Zürich and Paul Scherrer Institut, Villigen, ''Ökoinventare von Energiesystemen'', 3rd edition 1996 and modified to fit UCPTE conditions and adapted to the demands of the EPD-guidelines (Environmental Product Declaration guidelines in Sweden). -- Brief description -- One wind power plant with an output of 30 kW has been inventoried in detail and two other plants (30 kW and 150 kW) also have been analysed with the help of the detailed study together with specific data for those plants. Construction, demolition and operation of the plants have been studied. The yield of studied plants is about 50% lower than the yield of plants at more windy locations at for instance the sea coast. Data has been aquired from literature and from a manufacturing plant for wind power plants and figures concerning consumption of energyware and materials, use of land and water, emissions to air and water and wastes have been picked out from or calculated based on those sources for all phases of the life cycle. All subsystems are described on a ''cradle-to-grave'' basis, including the main stages, i.e. data concerning consumption of resources and emissions is included for the manufacturing of main materials, waste handling and energyware used in the lifecycle. Energyware (fuels and electricity) is used during construction (ground works), in material manufacturing processes, transports etc. -- Detailed description -- Construction and demolition of power plant (30kW/30kW/150kW) The plants consists of a 18/22/30 m high tower made of painted, galvanized steel with a basal of reinforced concrete. Further the plant has a rotor (diameter 12,5m/12,5m/23,8m) with two/two/three blades made of glass fibre reinforced plastic, a generator and a gear box, a break, a hydraulic system (12 l oil) and electronics.

	Material production, component production, galvanization, transports, welding and ground work (incl. blasting) are included. Several materials are assumed to be recycled after dismantling the rest is put in landfills or is left in the ground (basal). Operation of power plant The change of gear oil (20 l) every 4 years as well as transportion is included. The electricity generation of the three plants is listed below together with the approximate share of respective wind mill type in the Swiss wind electricity mix, adapted to the real set of Switzerlands 7 grid connected wind mills: Power Yield Share Operation time (full load) 30kW 20 864 kWh 15% 695 h 30kW 14 868 kWh 11% 496 h 150kW 99 964 kWh 74% 666 h For here reported figures the average operation time has been doubled (after recommendation of Dr. Rolf Frischknecht) to better correspond to the UCPTE situation i.e. resulting figures are 50% of those reported in the original study. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.

System Boundaries	
Nature Boundary	Used materials and energyware have been followed from extraction and processing of natural resources. Maufacturing processes for the use of recycled material are accounted for. Emissions from energyware use in manufacturing processes and transports (infrastructure and vehicle construction included) are considered as well as emissions from landfills (infrastructure included) where waste material is disposed of. Waste material supposed to be recycled are outputs of the system (i.e. those recycling processes are not included). ETH:s LCI-results comprise all parameters received during inventory and calculation, i.e. no selection has been made by ETH. Vattenfall's criterion in selecting and aggregating ETH's LCI-results for electricity generation in the UCPTE region has been to make the figures usable as general electricity LCI data in EPDs according to Miljöstyrningsrådets guidelines. Especially parameters (emissions) which have established impact indices - accepted by the EPD system - for one or several environmental impact categories, have been picked out and aggregated as far possible. But also metal and energyware resources have been included, as well as waste, in spite of all waste handling processes related to this dataset being included with respect to use of resources and emissions. The latter is an adaption to other LCI data for electricity generation where waste amounts are reported (since those flows have not been followed to the grave). Since ETH claimes that most of the figures regarding metal emissions have an undefined amount of datagaps all metal emissions are aggregated except for a few which are specified separatly since they are reported for most processes in the lifecycle. Metals are reported as elements although they often are part of compounds. Measuring methods often just give the amounts of the different elements found. All hydrocarbons to water are aggregated to one parameter as well as halogenated organics, since no indices exist (that are accepted by the EPD system so far) for characterisation of the individual substances.
Time Boundary	Different technical lifetimes/reference times for different parts of the studied systems have been used as follows: Moving parts 20 years Fixed parts 50 years
Geographical Boundary	No geographical boundaries have been drawn except concerning the location of the studied plants in Switzerland and the consumption of generated electricity in the UCPTE* region. All transports with wind mill parts are assumed to come from Germany. Processes conducted outside the UCPTE* region are supposed to be supplied with UCPTE* electricity. Data concerning the use of resources, emissions and waste in connection with manufacturing processes mainly originate from sources in Switzerland, Germany and other western European countries. * Union pour la coordination de la production et du transport de l'életricité, following countries were members of the union in 1994: Belgium, Germany, France, Greece, Italy, Ex-Jugoslavia (Bosnia/Herzegowina, Croatia, Slowenia, and Rest-Jugoslavia), Luxemburg, Netherlands, Austria, Portugal, Switzerland, Spain.
Other Boundaries	Manufacturing processes of components and machines have been approximated with 50% of the energyware used to produce contained materials. Energyware figures concerning material production come from literature and have assumed to be a mix of 10% UCPTE electricity, 45% oil and 45% natural gas. This approximation has been confirmed in more

	thorough calculations in ETH:s LCA for coal power. The ETH study comprises figures concerning use of land, usable content in water storages and amount of turbine water which have not been reported here. The two latter have been excluded due to lack of corresponding data in comparable studies. Use of land has been excluded here because of ETH's advanced approach. Land is divided into two main groups - land and sea - which are subdivided into 4 categories each. Land Criterion Category Natural human impact not larger than other species' since the indutrial revolution I Modified human impact larger than other species', low degree of culivation II Cultivated human impact larger than other species', large degree of cultivation III Built upon dominated by buildings, roads, dams, mines etc. IV Category I is not used in the study. State of land before, during and after exploitation is of intererst. If a piece of land is used again after some kind of exploitation it will either end up in the same category or in a higher one. ETH takes into account not only the land used during the technical lifetime of the studied system but also during the construction phase and during the time it takes to restore the land. they express use of land in the unit m2year which is diffrent from comparable Swedish studies (m2). See times for restoration of land below: From category IV to category III 5 years From category III to category II 50 years From category II to category I 100 000 years (For uranium mines the restoration time to category II is 80'000 years due to elevated radiation caused by long-living radioactive compounds.) ETH specifies about 160 radioactive isotopes emitted to air and water. Radioactive emissions reported here are picked out in accordance with SETAC working group report on data quality and data availability (to be published in 2001). Big accidents occuring seldomly are not included.The threshold is fixed at 10 accidents per year if one energy carrier/system (e.g. oil) would cover the entire primary energy demand of the world.
Allocations	The cutoff-method has been used for material use, i.e. 100% of the environmental load for virgin and recycled material used in the lifecycle is included whereas no environmental load has been considered for materials leaving the system to be recycled. Landfill processes and waste incineration, however, are included for waste arising during the lifecycle.
Systems Expansions	

Flow Data

General Activity QMetaData

Date Conceived	1985 to 1995
Data Type	Derived, unspecified
Represents	Approximate average wind power in the UCPTE in 1994.
Method	The data has been adapted from the Ökoinventare von Energiesystemen, ETH Zürich 1996, and is an aggregation of the LCI results for the module ''Electricity from wind power, Switzerland'' (Windmix CH) (divided by two since operation times in Switzerland are very low in comparison to the average in the UCPTE).
Literature Reference	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Environmental Life-Cycle Inventories of Energy Systems An Environmental Database for the Accounting of Energy Consumption in Product Life-Cycle Assessment and the Comparative Assessment of Energy systems Prof. Dr. P. Suter, R. Frischknecht, et al Swiss Federal Institute of Technology, Zürich R. Dones, U. Gantner Paul Scherrer Institute, Villigen/Würenlingen
Notes	

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Bauxite	22.7			kg	Ground	
	Input	Natural resource	Chromium in ore	2.01			kg	Ground	
	Input	Natural resource	Copper in ore	41.4			kg	Ground	
Notes: From drillhole	Input	Natural resource	Crude oil	670			kg	Ground	

Notes: Before processing	Input	Natural resource	Hard coal	1530			kg	Ground	
	Input	Natural resource	Iron in ore	1315			kg	Ground	
	Input	Natural resource	Lead in ore	0.238			kg	Ground	
Notes: Before extraction	Input	Natural resource	Lignite	233.5			kg	Ground	
	Input	Natural resource	Limestone	755			kg	Ground	
	Input	Natural resource	Manganese in ore	2.45			kg	Ground	
Notes: Summation of ''Erdoelgas'' (40,9 MJ/Nm3), ''Grubengas'' (35,9 MJ/kg) and ''Rohgas'' (35 MJ/Nm3). Expressed as Natural gas with lower heating value (35 MJ/Nm3). The heating values are acquired from table III 8.1 in the methodology chapter in the Ökoinventare von Energiesystemen, ETH, Zürich 1996	Input	Natural resource	Natural gas	378.9			Nm3	Ground	
	Input	Natural resource	Nickel in ore	0.0535			kg	Ground	
	Input	Natural resource	Palladium in ore	0.000001935			kg	Ground	
	Input	Natural resource	Platinum in ore	0.000054			kg	Ground	
	Input	Natural resource	Rhodium in ore	0.000002095			kg	Ground	
	Input	Natural resource	Rock salt	50.5			kg	Ground	
	Input	Natural resource	Uranium in ore	0.01665			kg	Ground	
	Input	Natural resource	Water	46450			kg	Ground	
	Input	Natural resource	Wood	15.7			kg	Ground	
	Input	Natural resource	Zinc in ore	8.7			kg	Ground	
Notes: Summation of Ag, Sn, Rh, Mo, Co.	Input	Refined resource	Metals	0.708			kg	Technosphere	
	Output	Emission	1,2-Dichloroethane	0.0346			kg	Air	
	Output	Emission	Ag-110m	0.0000067			kBq	Air	
	Output	Emission	Ag-110m	0.04575			kBq	Water	
	Output	Emission	Am-241	0.0001285			kBq	Air	
	Output	Emission	Am-241	0.0169			kBq	Water	
Notes: BOD5	Output	Emission	BOD	0.133			kg	Water	
	Output	Emission	C-14	0.855			kBq	Water	
	Output	Emission	C-14	10.5			kBq	Air	
	Output	Emission	C-60	0.000288			kBq	Air	
	Output	Emission	Cd	0.0000222			kg	Ground	
	Output	Emission	Cd	0.00132			kg	Air	
	Output	Emission	Cd	0.00972			kg	Water	
	Output	Emission	CFC-11	0.00000525			kg	Air	
	Output	Emission	CFC-114	0.0001395			kg	Air	
	Output	Emission	CFC-12	0.00000113			kg	Air	
	Output	Emission	CFC-13	0.00000071			kg	Air	
	Output	Emission	Cm alpha	0.0002035			kBq	Air	
	Output	Emission	Cm alpha	0.0224			kBq	Water	
	Output	Emission	Cm-244	5.95E-09			kBq	Air	
Notes: CN- is Cyanide ion	Output	Emission	CN-	0.0004011			kg	Air	
	Output	Emission	CN-	0.00564			kg	Water	
	Output	Emission	CO	34.61			kg	Air	
	Output	Emission	CO2	4578			kg	Air	
	Output	Emission	Co-58	0.00019			kBq	Air	
	Output	Emission	Co-58	0.096			kBq	Water	
	Output	Emission	Co-60	3.778			kBq	Water	
	Output	Emission	COD	0.305			kg	Water	

	Output	Emission	Cr	0.000227			kg	Ground	
	Output	Emission	Cr	0.001497			kg	Air	
	Output	Emission	Cr	0.0281			kg	Water	
	Output	Emission	Cs-134	0.00487			kBq	Air	
	Output	Emission	Cs-134	0.865			kBq	Water	
	Output	Emission	Cs-137	0.0094			kBq	Air	
	Output	Emission	Cs-137	7.97725			kBq	Water	
	Output	Emission	Dichloromethane	0.0000775			kg	Air	
Notes: 2,3,7,8-Tetrachlorodibenzo-p-Dioxin-equivalents	Output	Emission	Dioxin (TCDD)	4420			ng	Air	
	Output	Emission	Dissolved solids	1.0015			kg	Water	
	Output	Emission	H-1301	0.0002595			kg	Air	
	Output	Emission	H2S	0.07396			kg	Air	
	Output	Emission	H-3	104.5			kBq	Air	
	Output	Emission	H-3	25340			kBq	Water	
Notes: Summation of AOX, 1,1,1-trichloroethane, chlorobenzene, dichloromonofluoromethane, ethylene dichloride, hexachlororethane, metylenchloride, tetrachloroethylene, trichloroethylene, trichloromethane.	Output	Emission	Halogenated organics	0.03256			kg	Water	
Notes: Summation of Cl-, F- and I-.	Output	Emission	Halogenids	68.52			kg	Water	
Notes: Summation of I and Br.	Output	Emission	Halogens	0.00155			kg	Air	
	Output	Emission	HCFC-21	0.0144			kg	Air	
	Output	Emission	HCFC-22	0.0000182			kg	Air	
	Output	Emission	HCl	0.801			kg	Air	
Notes: No available index. Same index as NMVOC.	Output	Emission	Hexachlorobenzene	2.645E-08			kg	Air	
	Output	Emission	Hexafluoroethane	0.000247			kg	Air	
	Output	Emission	HF	0.03575			kg	Air	
	Output	Emission	HFC-134a	1.74E-16			kg	Air	
	Output	Emission	Hg	0.000000174			kg	Ground	
	Output	Emission	Hg	0.0002296			kg	Air	
	Output	Emission	Hg	6.679E-05			kg	Water	
Notes: Summation of acenaphtene, acenaphtylene, alkane, alkene, aromats, benzene, butyl benzyl phtalat, bibutyl p-phtalat, dimethyl p-phtalat, ethylbenzen, volatile hydrocarbons, formaldehyd, glutaraldehyd, hydrocarbons, MTBE (Metyl Tertiary Butyl Eter), phenol, styrol, toluol, triethylenglycol, xylol.	Output	Emission	Hydrocarbons	0.0653			kg	Water	
	Output	Emission	I-129	0.03665			kBq	Air	
	Output	Emission	I-129	2.445			kBq	Water	
	Output	Emission	I-131	0.001855			kBq	Water	
	Output	Emission	I-131	0.00515			kBq	Air	
	Output	Emission	I-133	0.00069			kBq	Water	
	Output	Emission	I-133	0.002225			kBq	Air	
	Output	Emission	K-40	0.0277			kBq	Air	
	Output	Emission	K-40	0.063			kBq	Water	
	Output	Emission	Kr-85	630000			kBq	Air	
Notes: Summation of the ions of following metals: Ag, Al, Ar, Ba, Be, Cs, Ca, Fe, K, Co, Mg, Mn, Mo, Na, Ni, Ru, Sb, Se, Sn, Sr, Ti, W.	Output	Emission	Metal ions	39.91			kg	Water	
Notes: Summation of Al, As, Ca, Co, Cu, Fe, Mn, Ni, Sn.	Output	Emission	Metals	0.3197			kg	Ground	
Notes: Summation of Al, As, Ba, Be, Ca, Co, Cu, Fe, K, La, Mg, Mn, Mo, Ni, Pt, Sb, Sc, Se, Sn, Sr, Th, Ti, Tl, U, Zr.	Output	Emission	Metals	0.498			kg	Air	
	Output	Emission	Methane	15.28			kg	Air	

	Output	Emission	Mn-54	0.00000685			kBq	Air	
	Output	Emission	Mn-54	0.574575			kBq	Water	
	Output	Emission	N	0.000086			kg	Ground	
	Output	Emission	N total	0.1516			kg	Water	
	Output	Emission	N2O	0.0755			kg	Air	
	Output	Emission	NH3	0.02146			kg	Air	
Notes: Summation of acetaldehyd, acetylene, aceton, acrolein, aldehyd, alkane, alkene, aromats, benzaldehyd, benzene, butan, buten, acetic acid, etan, etanol, etene, ethylbenzene, ethylenoxide (C2H4O), formaldehyd, heptan, hexan, metanol, MTBE (Metyl Tertiary Butyl Eter), NMVOC, pentane, phenol, propan, propen, propion aldehyd, propionic acid, styrol, toluol, xylol.	Output	Emission	NMVOC	10.54			kg	Air	
	Output	Emission	NO2-	0.000784			kg	Water	
	Output	Emission	NO3-	0.0542			kg	Water	
Notes: as NO2	Output	Emission	NOx	9.845			kg	Air	
	Output	Emission	Np-237	0.00108			kBq	Water	
	Output	Emission	Oil	0.028896			kg	Ground	
	Output	Emission	Oil	0.685			kg	Water	
	Output	Emission	P	0.00259			kg	Ground	
	Output	Emission	P total	0.000385			kg	Air	
	Output	Emission	PAH	0.0005585			kg	Water	
Notes: Same index as NMVOC.	Output	Emission	PAH	0.000849444			kg	Air	
	Output	Emission	Particles	12.1575			kg	Air	
	Output	Emission	Pb	0.0000229			kg	Ground	
	Output	Emission	Pb	0.02671			kg	Air	
	Output	Emission	Pb	0.0348			kg	Water	
	Output	Emission	Pb-210	0.0505			kBq	Water	
	Output	Emission	Pb-210	0.1433			kBq	Air	
Notes: C6HCl5, no available index. Same index as NMVOC.	Output	Emission	Pentachlorobenzene	7.05E-08			kg	Air	
Notes: C6HCl5O, no available index. Same index as NMVOC.	Output	Emission	Pentachlorophenol	1.14E-08			kg	Air	
	Output	Emission	Po-210	0.0505			kBq	Water	
	Output	Emission	Po-210	0.2243			kBq	Air	
	Output	Emission	PO43-	0.149			kg	Water	
	Output	Emission	Pu alpha	0.0004075			kBq	Air	
	Output	Emission	Pu alpha	0.067			kBq	Water	
	Output	Emission	Pu-238	1.48E-08			kBq	Air	
	Output	Emission	Ra-226	0.15325			kBq	Air	
	Output	Emission	Ra-226	314.385			kBq	Water	
Notes: Long-term emissions of Rn-222	Output	Emission	Rn-222	905000			kBq	Air	
	Output	Emission	Rn-222	9856.45			kBq	Air	
	Output	Emission	Ru-106	0.04075			kBq	Air	
	Output	Emission	Ru-106	4.075			kBq	Water	
	Output	Emission	S	0.02725			kg	Ground	
Notes: Includes Tot-S, S-, S in H2S, S in sulphate, S in sulphite	Output	Emission	S total	4.542			kg	Water	
	Output	Emission	Sb-124	0.00000186			kBq	Air	
	Output	Emission	Sb-124	0.0127			kBq	Water	
	Output	Emission	Sb-125	0.000000326			kBq	Air	
	Output	Emission	Sb-125	0.001225			kBq	Water	
	Output	Emission	SO2	19.04			kg	Air	
	Output	Emission	Sr-90	0.0067			kBq	Air	
	Output	Emission	Sr-90	0.8151255			kBq	Water	
	Output	Emission	Suspended solids	5.125			kg	Water	
	Output	Emission	Tc-99	0.000000285			kBq	Air	
	Output	Emission	Tc-99	0.428			kBq	Water	
	Output	Emission	Tetrachloromethane	0.00815			kg	Air	
	Output	Emission	Tetrafluoromethane	0.002225			kg	Air	

	Output	Emission	Th-230	0.04535			kBq	Air	
	Output	Emission	Th-230	11.8			kBq	Water	
	Output	Emission	Th-232	0.00735			kBq	Air	
	Output	Emission	Th-232	0.01175			kBq	Water	
Notes: Summation of dissolved organic carbon, fat acids as C, volatile organic compounds as C, TOC.	Output	Emission	Total organic carbon	48.39			kg	Water	
	Output	Emission	Tributyl tin	0.0001385			kg	Water	
	Output	Emission	Trichloromethane	0.000915			kg	Air	
	Output	Emission	U-234	0.04885			kBq	Air	
	Output	Emission	U-234	0.101			kBq	Water	
	Output	Emission	U-235	0.002365			kBq	Air	
	Output	Emission	U-235	0.1505			kBq	Water	
	Output	Emission	U-238	0.0692			kBq	Air	
	Output	Emission	U-238	0.256			kBq	Water	
	Output	Emission	V	0.01246			kg	Water	
	Output	Emission	V	0.0149			kg	Air	
	Output	Emission	Vinyl chloride	0.00565			kg	Air	
	Output	Emission	Xe-133	451.5			kBq	Air	
	Output	Emission	Zn	0.000725			kg	Ground	
	Output	Emission	Zn	0.0560			kg	Water	
	Output	Emission	Zn	0.13505			kg	Air	
	Output	Product	Electricity	1			TJ	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) and processing of hazardous waste is included.	Output	Residue	Hazardous waste	0.975			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Highly radioactive waste	0.00000285			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, no emissions from landfill assumed. Inert waste deposit is waste at landfill that are inert.	Output	Residue	Inert waste deposit	765			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Low radioactive waste	0.0001515			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included.	Output	Residue	Medium and low radioactive waste	0.000035			m3	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from landfill. Reactive waste deposit is waste at landfill that is still reactive.	Output	Residue	Reactive waste deposit	221.5			kg	Technosphere	
Notes: Internal flow! Infrastructure of spreading vehicles and emissions are included. Land farming is a treatment of organic sludge, the sludge is spread on a piece of land and left to degrade. Sometimes plants are grown on the land, but those plants are destroyed.	Output	Residue	Waste in land farming	4.775			kg	Technosphere	
Notes: Internal flow! Infrastructure (resources and emissions) included, as well as emissions from incineration plant.	Output	Residue	Waste to incineration	25.45			kg	Technosphere	

About Inventory

Publication	Ökoinventare von Energiesystemen, Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ETH, Eidgenössische Technische Hochschule, Zürich, Gruppe Energie - Stoffe - Umwelt (ESU), Paul Scherrer Institut, Villigen/Würenlingen, Sektion Ganzheitliche Systemanalysen Available on CD-ROM with full documentation (in German) at http://www.energieforschung.ch.

	--- Data documented by: Caroline Setterwall, Swedpower, Vattenfall AB, Sweden Documentation reviewed by (see also Notes): Rolf Frischknecht, ESU-services, Switzerland Ann-Christin Pålsson, CPM, Chalmers University of Technology, Sweden ---
Intended User	Original study of ETH: LCA pra
General Purpose	The purpose of the ETH study was to examine a number of energy systems quantitatively and to the same extent with respect to environmental issues during their lifecycles. The results can be used in lifecycle assessments, as basis information in decisionmaking regarding environmental optimisation or in working with municipal energy plans. Vattenfalls purpose - as a commissioner of putting ETH:s data into Spine format with metadata - is to supply EPD-practitioners with general LCA-data for electricity generation to be used in absence of specific data in accordance with the directions of Miljöstyrningsrådet (The Swedish Environmental Management Council) and the Swedish EPD-guidelines. Data is supposed to be used together with IEA statistics about electricity generation mixes in the OECD countries/regions.
Detailed Purpose	ETH:s aim was to examine some important aspects of the environmental impact of wind power plants in Switzerland with respect to construction, operation and demolition.
Commissioner	BEW, PSEL - Bundesamt für Energiewirtschaft, Projekt- und Studienfonds der Elektrizitätswirtschaft .
Practitioner	Rolf Frischknecht et al - ETH, Eidgenössische Technische Hochschule, Institut für Energietechnik, Zürich and Paul Scherrer Institut, Sektion Ganzheitliche Systemanalyse, Villingen/Würenlingen .
Reviewer	None, see further under notes -
Applicability	Here reported LCI-results of wind power are supposed to be valid for the UCPTE. This set of data is aggregated and documented in accordance with the Swedish EPD-guidelines to be used in combination with IEA statistics concerning electricity generation mixes in OECD countries and regions together with other datasets - based on the ETH study - describing other power generation systems. The EPD-adapted power generation systems in Spine format are named as follows: Fuel gas electricity energy system, EPD-version Biofuel electricity energy system, EPD-version Hydro electricity energy system, EPD-version Lignite electricity energy system, EPD-version Nuclear electricity energy system, EPD-version Stone coal electricity energy system, EPD-version Wind electricity energy system, EPD-version IEA statistics for generation mixes 1998 exist in Spine format for the following 30 countries/regions: OECD total OECD North America OECD Pacific OECD Europe European Union Australia Austria Belgium Canada Czech Rpublic Denmark Finland France Germany Greece Hungary Iceland Ireland Italy Japan Korea Luxembourg Mexico Netherlands New Zealand Norway Poland Portugal Spain Sweden Switzerland Turkey United Kingdom United States

About Data	For an application of ETH data for wind power in UCPTE countries, the production volume per installed kW is doubled, since operation time in Switzerland is much lower than average operation times of wind power plants in the UCPTE. Hence emission and resource consumption figures reported here are 50% lower compared to the original data in the ETH study, which only covers the Swiss situation. Material manufacturing processes have been inventoried with a low degree of exactitude (except for steel, cement, aluminium, copper, bitumen, and platinum group metals for which rather detailed LCI data are provided). Results are reported with three figures, but it is stated in the original source that this does not mean that accuracy is that high (Part III, p.16). For references and sources of reported figures see further under Function, Nature boundary, Geographical boundaries, Publication, Notes and General metadata.
Notes	Reviewer of this specification of ETH:s data and metadata has been: Dr. Rolf Frischknecht, ESU-services (earlier at ETH) - approval of aggregation of figures and of Vattenfall's interpretation ot the documentation Ann-Christin Pålsson, CPM - review of documentation quality according to the CPM data documentation requirements. The technical committee of the Swedish Environmental Management Council - approval of method and aggregation of parameters Project Management of the ETH study, 3rd edition: Professor, Dr. P. Suter and R. Frischknecht, ETH Editorial staff of the 1st edition: R. Frischknecht, P. Hofstetter, I. Knoepfel, M. Ménard, ETH R. Dones, E. Zollinger, Paul Scherrer Institut Authors of the 1st edition: N. Attinger, T. Baumann, G. Doka, R. Dones, R. Frischknecht, H.-P. Gränicher, C. Grasser, P. Hofstetter, I. Knoepfel, M. Ménard, H. Müller, M. Vollmer, E. Walder, E. Zollinger Authors of the revision, 3rd edition: U. Bollens, S, Bosshart, M. Ciot, L. Ciseri, G. Doka, R. Frischknecht, R Hischier, A. Martin, ETH R. Dones, U. Gantner, Paul Scherrer Institut -- --- Changes made to the data set after publishing in SPINE@CPM--- >>> 6 June 2001: <<< The following changes has been made in the nomenclature for in- and outflows: Mangane in ore -> changed to: Manganese in ore CH4 -> changed to: Methane (to be in accordance with the nomenclature specified in CPM report 2000:2) CN -> changed to: CN- Stone coal -> changed to: Hard coal (to be in accordance with the nomenclature specified in CPM report 2000:2) Other metals -> changed to: Metals Explanations of nomenclature (inserted in Notes for the specific flows): - CN- is Cyanide ion - Reactive waste deposit is waste at landfill that is still reactive. - Inert waste deposit is waste at landfill that are inert. Additional clarifications: - Note that the flows of waste in the table of in- and outflows are internal flows, i.e. they do NOT cross the system boundaries. All waste handling processes is included in the study with respect to use of resources and emissions. - Radioactive waste is accounted for in cubic metres. The product specific requirements for electricity and district heating generation (PSR 1998:1) in the Swedish EPD system states that waste shall be accounted for in gram. However, no conversion factors were given in the study. There are also no general conversion factors that are commonly used.

SPINE LCI dataset: Wind power plant with support systems

Administrative	
Finished	Y
Date Completed	1996-12-01
Copyright	
Availability	Public

Technical System	
Name	Wind power plant with support systems
Functional Unit	Net production of 1 kWh electricity
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh electricity.
Process Type	Cradle to gate
Site	Näsudden, Gotland
Sector	Grid electricity and district heat
Owner	Näsudden, Gotland
Technical system description	The studied system concerns the *operation and maintenance of a 500 kW wind power plant.* To represent the electricity production in Vattenfall:s wind-power plants, Nordic 500 have been used. The time of use, i.e. real operation time recalculated as operation time at full effect is assumed to be 1500 hours, giving an electricity production of 18750 MWh during an assumed life-time of 25 years. Production of materials, chemicals and electricity and transports, used in association with operation and maintenance of the plant are included. To operate the wind power plant, no resources are used except lubricating oil and fuels for transports. The components of the power plant can be recycled. At operation and maintenance, mainly steel and copper are replaced. Some of it is recycled, and the rest is assumed to be transferred to scrap handling or final waste. Vattenfall owns twelve wind power plants, on Gotland, at Lysekil on Utö in the archipelago off Stockholm and in Skåne. Together they produce 16 GWh electricty per year, which is 0,2 per mille of the electricity production of Vattenfall.

System Boundaries	
Nature Boundary	All emissions are considered equivalent, independent of where they take place (locally, regionally, globally; in densely populated areas or rural areas).
Time Boundary	A power plant of 500 kW is currently common. In the future, units of 1000-1500 kW will probably be more common.
Geographical Boundary	The plant is located on Näsudden, Gotland.
Other Boundaries	The studied system includes *operation and maintenance of a wind power plant of 500 kW*. Calculations concerning erection and demolition of the plant has been performed but are not included in this system. ***Sub-systems included in the system:*** • Internal use of electricity in the plant e g. for lighting and warning lamps are taken into account in the calculation for electricity production. • Use of resources and emissions associated with reinvestments and reconstruction, except bed (fundament) and blades. • Known use of chemicals are accounted for. In the cases where it was possible to obtain data, resource use and emissions for the production are included. • Use of resources and emissions to air from production of the electricity that is used in the life cycles, distributed on the different production alternatives. • Energy use and emissions for the production of oil for the studied manufacturing processes and transports. ***Sub-systems excluded from the system:***

	• Equipment after the power station transformer. • Waste and rest products are transported to final waste. Operation and chemical and biological decomposing processes in the final waste have not been considered. • The risk of major accidents and rare breakdowns and environmental consequences from these. • Work environment. • Environmental loads caused by the operation personnel (mainly transports to and from work.
Allocations	The *50/50 method* has been applied throughout the calculations. The method is described in ''Nordic Guidelines on Life-Cycle Assessment'', Nord 1995:20, The Nordic Council, Stockholm.
Systems Expansions	N/A (unless aggregated system from special type of comparative LCI study)

Flow Data

General Activity QMetaData

Date Conceived	1996-01-01
Data Type	Derived, unspecified
Represents	Approximate average wind power in the UCPTE in 1994.
Method	An LCA calculation of the operation and maintenance of an 500 kW wind power plant, with a time of use of 1500 hours.
Literature Reference	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', in Swedish, Vattenfall AB
Notes	The parameters that are presented are chosen because they have a general interest and because the basis for these parameters is relatively good. All values are reported with 3 figures. Data is however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Notes: Includes a 300 m protective radius.	Input	Natural resource	Area	.015100			m2	Ground	
	Input	Natural resource	Bio fuel	0.000001			kWh	Other	
	Input	Natural resource	Coal	0.00146			kWh	Other	
Notes: The data has been allocated.	Input	Natural resource	Copper ore	0.59			mg	Ground	
Notes: The data has been allocated.	Input	Natural resource	Iron ore	0.0412			g	Ground	
	Input	Natural resource	Natural gas	0.000005			kWh	Other	
Notes: Electricity produced by nuclear power. For the production of 1 kWh electricity, 1,24 g uranium ore is used.	Input	Refined resource	Electricity	.000002			kWh	Technosphere	
Notes: Electricity produced by water power.	Input	Refined resource	Electricity	0.000007			kWh	Technosphere	
Notes: Includes oil and diesel	Input	Refined resource	Heavy oil	0.000032			kWh	Technosphere	
Notes: There are data gaps for e.g. the production of copper and cement.	Output	Emission	CO	32.5			ug	Air	
	Output	Emission	CO2	.060700			g	Air	
Notes: Accounts for the total HC. There are data gaps e.g. the production of copper and cement.	Output	Emission	HC	16.4			ug	Air	
	Output	Emission	NOx	.139000			mg	Air	
Notes: There are data gaps e.g. the production of copper, cement and lubricating oil.	Output	Emission	N-tot	.432000			ug	Water	
Notes: There are data gaps for e.g. the production of lubricating oil.	Output	Emission	Particles	33.000000			ug	Air	
	Output	Emission	SO2	.152000			mg	Air	

	Output	Product	Electricity	1.000000			kWh	Technosphere	
	Output	Residue	Building waste	.367000			g	Technosphere	
Notes: There are large data gaps.	Output	Residue	Other rest products	0.0131			g	Technosphere	

About Inventory	
Publication	Brännström-Norberg B-M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S.,''Livscykelanalys för Vattenfalls elproduktion - Sammanfattande rapport'', Vattenfall AB Data documented by: Ann-Christin Pålsson, CPM/TEP, Chalmers University of Technology
Intended User	The data can be used as a basi
General Purpose	• The work with life-cycle analysis is expected to *contribute to a reinforcement and structuring* of the environmental work within Vattenfall, and a deeper knowledge on the use of resources and emissions to the environment. • An LCA can *facilitate a need for reliable data for electricity production*. Electricity is used in the manufacture of almost every product, and data from an LCA can be used when conducting an LCA on products. • An LCA can *facilitate a choice between different techniques* for future electricity production. • An LCA can also help to *choose the most effective alternatives* to reduce the consumption of resources and environmental influence of the current electricity production system. • It is also possible to *compare* the environmental load for different alternatives of electricity production.
Detailed Purpose	To obtain a *reliable basis* to be able to perform life-cycle analyses of different types of electricity use, and to identify opportunities for improvements in the existing system. To identify data gaps and areas where the knowledge is poor.
Commissioner	- Vattenfall Elproduktion .
Practitioner	- Vattenfall Energisystem AB: Britt-Marie Brännström-Norberg Ulrika Dethlefsen Roland Johansson Caroline Setterwall Sofie Tunbrant .
Reviewer	- Thomas Ekvall, Chalmers Industriteknik (CIT) Gunnar Lindfors, Institutet för Vatten- och Luftvårdsforskning (IVL) Göran Finnveden, Institutet för Vatten- och Luftvårdsforskning (IVL)
Applicability	The analysis is based on data from a plant that is chosen to make the analysis representative for the operation and maintenance of Vattenfall:s wind power plants. The data is primarily valid for a wind power plant of 500 kW, which is an ordinary size today. Units of 1000-1500 kW will however shortly be on the market. The data is reliable since a specific plant has been studied. The consequence is however that the result is primarily valid for the studied plant. Thoroughly reliable data for every power source, requires life cycle analyses for a large number of power plants for every power source. Transmission and distribution losses are not included. When the result is used to study different types of electricity use, these losses should be included. A rough estimate are that the distribution losses for a large industry customer are approximately 5% of the bought electricity, i.e. to obtain data for the use of electricity the data should be multiplied with 1,05. For an average household customer the transmission losses are approximately 10% of the bought electricity, i.e. the data should be multiplied with 1,10. *If the result should be applied to another size of power plant* the material quantities need to be adjusted. A wind power plant on 500 kW has a tower height of 40 m, a rotor diameter of 40 m and calculated annual electricity production of 1100 MWh. For a power plant of 250 kW, tower height 32 m, rotor diameter 32 m and calculated annual production of 550 MWh, the material quantities are related as 0,8 to the material quantities of the 500 kW power plant. For a power plant of 1 MW, tower height 60 m, rotor diameter 60 m and calculated annual production of 2400 MWh, the material quantities are related as 1,5 to the

	500 kW power plant. The *operation time* varies depending on position and wind situation. The choice of time of use has a great influence on the result. The data apply to an operation time of 1500 hours. The environmental load for 1500 hour operation is 40% larger than for a 2500 hour operation time. The complete study include erection, operation and maintenance, and demolition of the power plant. When the data is used for energy production in a life cycle analysis of a product or a system, that do not require expansion of the electricity generation system, it is however reasonable to include only operation and maintenance of the plant. The other phases of the life cycle, i.e. erection and demolition, do not depend on the electricity production.
About Data	Data for the use of resources and energy are *specific for the operation of Nordic 500*, a power plant of 500 kW. The time of use, i.e. real operation time recalculated as operation time at full effect is assumed to be 1500 hours, giving an electricity production of 18750 MWh during the assumed life-time of 25 years. Calculations for an operation-time of 2500 hours, which gives an electricity production of 31250 MWh during 25 years, have been performed but are not reported. To operate the wind power plant, no resources are used except lubricating oil and fuels for transports. The components of the power plant can be recycled. At operation and maintenance, mainly steel and copper are replaced. Some of the metals is recycled, and the rest is assumed to be transferred to scrap handling or final waste. Since metals will be recycled to a large extent only a small part will go to final waste. These materials are not followed to the grave. The influence on the result because of this is difficult to assess. Relevant data for transports, extraction and production of metals and chemicals, and manufacture and work on important components were hard to obtain. Data from manufacturers and other reports and studies, primarily life cycle analyses have been used. Production of material and transports are considered with current technology. Swedish standard values have been used to calculate fuel use and emissions from transports. Transport distances are specific for the operation of the plant. *The parameters that are presented* are chosen because they have a general interest and because the basis for these parameters is relatively good. All values are reported with 3 figures. Data is however seldom that accurate. Use of resources and emissions associated with *reinvestments and reconstruction* are generally assumed to give an addition of 1 % per year of the use of resources and emissions at the building phase. The bed (fundament) and blades are however not considered to need renewal during the lifetime of the power station. The following data has been used in the analysis (tonnes per year during 25 years): Steel: 0,3 Copper: 0,008 PVC: 0,0005 Natural rubber: 0,0005 Lubricating oil: 0,005 For electricity used in the manufacture of materials and fuels, *average electricity* for the respective countries distributed on the different electricity production alternatives has been used. The following *degrees of efficiencies* have been used to calculate the fuel used in the electricity production. The values are standard values for existing power plants. New modern plants often have higher degrees of efficiencies. The values are calculated from the effective heating value in the used fuels and the energy content in the steam produced in a nuclear power plant. • Coal condensing: 40% • Oil condensing: 40% • Natural gas condensing/combination: 40% • Gas turbine: 25% • Combined heat and power plant(irrespective of fuel) 30%

	(for electricity production) 85% (total for electricity and heat production) • Hydro power: is not recalculated, is accounted for as kWh electricity • Nuclear power: 33%, is however not recalculated, but accounted for as kWh electricity or gram natural uranium.
Notes	Wind power is a temporary power source, only available when it is windy enough. Wind power influence the environment through an altered landscape and noise. It requires a relatively large area in proportion to the power production. The lower the electric power of the plant, the larger the land use per produced kWh. When the wind power plants are demolished the landscape should however be able to return to the ground- and water use before the land was claimed. Noise can be disturbing. Today, the communities generally apply a protective distance of 300-500 m.

SPINE LCI dataset: Vinyl flooring. ESA-DBP

Administrative	
Finished	Y
Date Completed	1994
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public.

Technical System	
Name	Vinyl flooring. ESA-DBP
Functional Unit	1 m2*year flooring
Functional Unit Explanation	Excerpt from the publication (see 'Publication'): ''The purpose of the study was to assess and compare the environmental impact from cradle to grave for floor coverings. The covering of one square metre of flooring during one year of operation was therefore chosen as the functional unit, or basis of comparison.'' 1 m2 of vinyl floor weighs 1.444 kg, including laying waste.
Process Type	Cradle to grave
Site	Not applicable
Sector	Construction
Owner	Not applicable
Technical system description	Excerpt from the publication: ''The life cycle of vinyl flooring. Polyvinyl chloride (PVC) is one of the main constituents of vinyl flooring. It is produced from sodium chloride (NaCl), ethylene and electric power. Ethylene originates from crude oil. The production of PVC is divided into three sub-processes: the production of chlorine, the production of vinyl chloride monomer (VCM) and the production of PVC. First, sodium chloride is electrolysed to sodium hydroxide (NaOH), chlorine (Cl,) and hydrogen (Hz). In the VCM factory, chlorine and ethylene are reacted to ethylene dichloride (EDC). VCM is then made from EDC. In the PVC factory, VCM is polymerised to PVC under high pressure. After polymerisation and drying, the PVC undergoes further processing. In the manufacturing of flooring, PVC granules are mixed with additives (plasticisers, pigments, fillers, lubricants, foaming agents, stabilisers, flame-proofing agents, etc.) under heat and pressure, and the mixture is pressed onto a backing of fibreglass fabric. The plasticiser mainly used in the product studied is dioctyl phthalate (DOP). The plasticiser is an important additive which makes the PVC permanently more plastic and stretchable. The pigment mainly used is titanium dioxide. Calcium carbonate is the main filler used in the product studied. Finally, a surface layer of polyurethane (PUR) is put on.''

	The flow chart for vinyl flooring can be found at page 248 in the publication. This system is described in: Jönsson et al, 1997, Life cycle assessment of flooring materials: case study. Building and Environment, Vol. 32, No. 3, pp. 245-255. Link to pdf: http://cpmdatabase.cpm.chalmers.se/DataReferences/Joensson_et_al_1997.pdf Other processes in the CPM Database also included in the above publication: Linoleum flooring. ESA-DBP Solid wood flooring. ESA-DBP Other processes in the CPM Database connected to the above publication: Dioctyl phthalate (DOP) production. ESA-DBP

System Boundaries

Nature Boundary	Not applicable.
Time Boundary	Data are applicable to the situation at the time, i.e. 1994.
Geographical Boundary	The scenarios describe a Swedish situation. The vinyl studied was produced in Sweden.
Other Boundaries	Excerpts from the publication (see 'Publication'): - Floorings for domestic use were studied. - It was assumed for the calculations that there is no recycling or recovery of the flooring materials, and that all materials are incinerated, with energy recovery, after use. - It was assumed that all pigments used consisted of titanium dioxide. - Some additives in the products were used in such small quantities that their environmental impact was disregarded in the study.
Allocations	Excerpt from the publication (see 'Publication'): ''The environmental impact of multi-output processes was allocated in proportion to the physical parameter most closely reflecting the economic value, which in most cases resulted in weight being used. No allocation was made between the two functions of incineration, waste elimination and heat production. Instead, the heat produced was reported as a useful energy flow leaving the systems analysed.''
Systems Expansions	Not applicable.

Flow Data

General Activity QMetaData

Date Conceived	1994
Data Type	Derived, mixed
Represents	See 'Function'.
Method	Excerpt from the publication (see 'Publication'): ''In this study, the necessary information was gathered from producing companies, authorities and the literature, including other LCA studies.''
Literature Reference	Jönsson et al, 1997, Life cycle assessment of flooring materials: case study. Building and Environment, Vol. 32, No. 3, pp. 245-255. Link to pdf: http://www.cpm.chalmers.se/CPMDatabase/DataReferences/Joensson_et_al_1997.pdf
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Calorific value	27.3			MJ	Technosphere	
Notes: Vinyl flooring production (raw material).	Input	Refined resource	Crude oil	1.42			kg	Technosphere	
Notes: Vinyl flooring production (53 %), PVC production (30%).	Input	Refined resource	Electricity	18.2			MJ	Technosphere	
Notes: Petrochemical industry (73%).	Input	Refined resource	Fossil fuel	26.5			MJ	Technosphere	
Notes: Vinyl flooring production (raw material).	Input	Refined resource	glassfibre	57.8			g	Technosphere	
Notes: Only accounted for as resource use (no other environmental loads are included). Titanium dioxide production.	Input	Refined resource	Sulphuric acid	130			g	Technosphere	

Notes: 6.25 kg ilmenite ore is required for production of 1 kg titanium dioxide. Vinyl flooring production (raw material).	Input	Refined resource	Titanium dioxide	43.3			g	Technosphere	
Notes: Vinyl flooring production (raw material).	Input	Resource	Limestone	86.6			g	Ground	
Notes: Vinyl flooring production (raw material).	Input	Resource	Rock salt	378			g	Ground	
Notes: Incineration.	Output	By-product	Recovered energy	16			MJ	Technosphere	
Notes: The parameter names overlap in some respects, but are nevertheless separated in the table, owing to the form in which the data have been given in the inventory. Vinyl flooring production.	Output	Emission	CH4	3.08			g	Air	
Notes: Processes and transports (fossil fuels).	Output	Emission	CO	0.51			g	Air	
Notes: Incineration (53%).	Output	Emission	CO2	4.14			kg	Air	
Notes: PVC production (75%).	Output	Emission	COD	0.65			g	Water	
Notes: Powdered limestone production (92%).	Output	Emission	Dust	6.79			g	Air	
Notes: Ethylene Dichloride/Ethylene Chloride/Vinyl Chloride Monomer PVC production.	Output	Emission	EDC/EC/VCM	0.56			g	Air	
Notes: Ethylene Dichloride/Vinyl Chloride Monome PVC production.	Output	Emission	EDC/VCM	0.65			mg	Water	
Notes: The parameter names overlap in some respects, but are nevertheless separated in the table, owing to the form in which the data have been given in the inventory. PVC production.	Output	Emission	Ethylene	57			g	Air	
Notes: Processes and transports (fossil fuels).	Output	Emission	HC	1.94			g	Air	
	Output	Emission	HCl	23.4			g	Air	
Notes: PVC production.	Output	Emission	Mercury	0.024			mg	Water	
Notes: PVC production.	Output	Emission	Mercury	0.057			mg	Air	
Notes: Processes and transports (fossil fuels).	Output	Emission	NOx	8.36			g	Air	
Notes: Emissions occurring during precombustion processes of fossil fuels (refining, etc.). Processes and transports (fossil fuels).	Output	Emission	N-tot	0.02			g	Water	
Notes: Emissions occurring during precombustion processes of fossil fuels (refining, etc.). Processes and transports (fossil fuels).	Output	Emission	Oil	0.03			g	Water	
Notes: Emissions occurring during precombustion processes of fossil fuels (refining, etc.). Processes and transports (fossil fuels).	Output	Emission	Phenol	0.49			mg	Water	
Notes: PVC production.	Output	Emission	PVC	0.048			g	Water	
Notes: Processes and transports (fossil fuels).	Output	Emission	SO2	4.87			g	Air	
Notes: PVC production.	Output	Emission	sodium formiate	0.078			g	Water	
Notes: The parameter names overlap in some respects, but are nevertheless separated in the table, owing to the form in which the data have been given in the inventory. Vinyl flooring production (94%).	Output	Emission	VOC	1.95			g	Air	
	Output	Product	Vinyl flooring	1			m2 year	Technosphere	
Notes: Incineration.	Output	Residue	Ash	801			g	Technosphere	
	Output	Residue	Hazardous waste	121			g	Technosphere	
Notes: Vinyl flooring production (74 %). Rock salt quarrying (24%).	Output	Residue	sector-specific waste	197			g	Technosphere	

About Inventory

Publication	Jönsson et al, 1997, Life cycle assessment of flooring materials: case study. Building and Environment, Vol. 32, No. 3, pp. 245-255. Link to pdf: http://cpmdatabase.cpm.chalmers.se/DataReferences/Joensson_et_al_1997.pdf
Intended User	LCA practitioners.
General Purpose	Excerpts from the publication (see 'Publication'): ''THE consequences of the human impact on the environment have become increasingly clear in recent years. A number of previously unknown environmental problems have emerged at local, regional and global levels, in spite of considerable efforts to decrease environmental emissions from identified point sources. Consequently, demands are now being made on the environmental soundness of products. From industry there is a demand for methods of improving products from the environmental point of view, both for internal use and for marketing purposes. Authorities need methods which can be used to assess the environmental consequences of product related decisions. Life cycle assessment (LCA) is becoming an increasingly important method for making product related environmental assessments.'' ''When applying LCA to building materials and components, special methodological problems arise because of the relatively long lifetime and the complex purpose of these products. Therefore, a project entitled ''Environmental Assessment of Buildings and Building Materials'' has been initiated at the Department of Technical Environmental Planning of Chalmers University of Technology (CTH). The case study of flooring materials presented in this article constitutes the first step in this project.''
Detailed Purpose	Excerpt from the publicatoin (see 'Publication'): ''The environmental impact of three flooring materials during their life cycles was assessed and compared using the LCA method. The objective was to make a specific comparison between the environmental impacts of the life cycle of some flooring materials and to develop a methodology for LCA of building materials.''
Commissioner	Not applicable - .
Practitioner	Jönsson, Åsa - Technical Environmental Planning Chalmers University ofTechnology Göteborg Sweden .
Reviewer	Tillman, Anne-Marie - Environmental Systems Analysis
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries'.
About Data	Excerpts from the publication (see 'Publication'): '' - The three studied products all have a calorific value and could alternatively be used as fuels. Since the energy recovered from incineration was accounted for as an energy gain, the calorific value of the materials was treated as an energy cost. - Production of electricity was not included in the systems analysed, due to lack of data. Electricity use was thus accounted for only as the amount used. When interpreting the results, the amount of electricity used reflects a number of environmental impacts, including flooded land from hydropower, radioactive waste from nuclear power and emissions to the air from fossil fuel based electricity production. - The environmental impact of cleaning and maintenance was omitted. It was roughly assumed that the cleaning habits are probably independent of what floor covering is used. In addition, no reliable data were available in this area.'' ESA Database Project. Years: 2009-2011. Documentation completed for this data set: 2010-09-15 Administering organisation: Chalmers University of Technology, the division of Environmental Systems Analysis. Financier: The Swedish Research Council. Documentor of data: Filippa Fuhrman (ESA). Review committee for documented data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	Not applicable.

SPINE LCI dataset: Virgin aluminium production

Administrative	
Finished	Y

Date Completed	1996-05-01
Copyright	
Availability	Public.

Technical System	
Name	Virgin aluminium production
Functional Unit	1 kg
Functional Unit Explanation	Inventory result for production of 1 kg aluminium from ore, at Hydro Aluminium in Karmoy, Norway.
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	BRIEF DESCRIPTION: The production of aluminium includes: (1) Bauxite mining (2) Bayer processing In the bayer process aluminium oxide is produced. The production of burnt lime (see section 2a) and NaOH (see section 2b) is included. (2a) Production of explosives, limestone mining and calcination are the process steps for burnt lime. The transports between these three processes are included. Production of explosives includes production of ammonium nitrate (extraction of natural gas, production of ammonia, nitric acid and ammonium nitrate), sodium nitrate, mineral oil, glass microballoons and aluminium powder. (2b) NaOH production includes salt mining and the transport to the NaOH production plant. (3) Prebake electrolysis or Söderberg electrolysis Prebake anode, aluminium fluoride and cathodes are used in the Prebake electrolyses. Aluminium fluoride, coal tar pitch, petroleum coke and cathodes are used in the Söderberg electrolysis. (3a) Prebake anode production includes coal tar pitch production and petrolium coke production. Coal tar pitch production includes crude tar production and the transport of tar to the coal tar pitch production plant. Petroleum coke production includes crude oil extraction, coking and hydrogenation, calcination of green coke and the transport of heavy oil to the coke plant and calcination. (3b) Aluminium fluoride production includes the transport of CaF_2 and aluminium hydroxide to the aluminium production plant. (3c) Cathode production includes steel production, carbon piece production, production of insulation stone and production of fire proof stone. The transport of steel, insulation stone, fireproof stone and carbon pieces to the cathode production plant and the transport of coal tar pitch and petrolium coke to the plant where the carbon pieces are produced, are also included. (3d) Coal tar pitch production (see (3a)). (3e) Petrolium coke production (see (3a)). Electricity production is included in this study, that is, emissions as well as fuel demand. PROCESS DESCRIPTION: (1) Bauxite mining Aluminium oxide is produced from bauxite in the Bayer process. Hydro Aluminium in Karnemoy buys aluminium oxide mainly from Jamaica and Guinea but since there are no data from these sites, it is assumed that the bauxite mining and the production of aluminium oxide takes place in Australia. After mining the ore is crushed and washed to remove sand and clay. Bauxite normally has an aluminium oxide content of 50-60%, wich equals about 25-30% aluminium. (2) Bayer processing In the bayer process aluminium oxide is produced. The production of burnt lime (see section 2a) and NaOH (see section 2b) is included. (2a) The production of burnt lime includes the production of explosives, limestone mining and calcination. The transports between these three processes are included. Production of

explosives includes production of ammonium nitrate (extraction of natural gas, production of ammonia, nitric acid and ammonium nitrate), sodium nitrate, mineral oil, glass microballoons and aluminium powder.

- Production of explosives

The production of explosives includes production of ammonium nitrate (extraction of natural gas, production of ammonia, nitric acid and ammonium nitrate), sodium nitrate, mineral oil, glass microballoons and aluminium powder.

Ammonium nitrate
Dyno Nitrogen in Ljungaverk, Sweden, produces the ammonium nitrate used in the production. According to Mr Hans Mattsson, production manager at Dyno Nitrogen, ammonia is bought from Hydro Agri in Landskrona, Sweden. Hydro Agri is assumed to import ammonia from Ukraine.

The produced ammonia is transported 3400 km, by train, from Ukraine to Dyno Nitrogen in Ljungaverk, Sweden. The mode of conveyance is assumed and the distance estimated.

Production of nitric acid starts with gasification of compressed ammonia. Air is added and the mixture is heated in the purpose to oxidise the ammonia to nitrogen oxides. The process gases are cooled and led to an absorption tower. The nitrogen oxides are absorbed and they react with water to nitric acid. 19,7% of the produced nitric acid is sold, the rest is used for the ammonium nitrate production.

Ammonium nitrate is carried out by mixing a 54% solution of nitric acid with gaseous ammonia in a reactor. Ammonia nitrate is formed in an exoterm reaction. The produced ammonium nitrate is sold in liquid, crystalline or in pilled form.

The ammonium nitrate is transported on the road from Ljungaverk, Sweden, to Kiruna, Sweden. The mode of conveyance is assumed and the distance, 866 km, is estimated.

Sodium nitrate
Sodium nitrate is produced through extraction from a nitrate mineral called Caliche. Caliche is found and mined in Chile, where also the sodium nitrate is refined. The mined mineral today has a content of about 7% sodium nitrate. It is imported to Sweden via Antwerp in the Netherlands.

The sodium nitrate is transported from Chile to Gothenburg in Sweden, via Antwerp, by boat and the distance is estimated to 15400 km. Further it is transported on the road from Gothenburg to Kiruna, and the distance is estimated to 1580 km.

Mineral oil
The production of mineral oil is approximated to the production of fuel oil and includes the extraction of crude oil, transport and refinery. The mineral oil is produced by Mobil in Uddevalla, Sweden, and is transported on the road for 1540 km to Kiruna, Sweden (the distance is estimated).

Glass microballoons
Microballoons are produced by MMM in France. The microballoons are transported 3000 km, from France to Kiruna, Sweden (estimation).

Aluminium powder
Aluminium powder is imported from Germany, Italy or Switzerland, but data has been used from the production of aluminium at Hydro Aluminium in Karmoy, Norway. The aluminium powder is transported from Germany, Italy and Switzerland to Kiruna, Sweden. The transport distance for aluminium powder is a mean value of the distance from Germany, Italy and Switzerland to Kiruna, Sweden, and is estimated to 3000 km.

The transport of emulsifier is assumed to be 300 km, on the road.

The data for the production of the explosive are valid for Kimlux at Kimit AB in Kiirunavara, Sweden.

- Limestone mining
The mining takes place in Japan, but data from Swedish mining is used. The mining process is very similar throughout the world. The system includes transportations in Japan.

- Calcination
The calcination also takes place in Japan, but more recent data is used from Mineral AB in Rättvik, Sweden. The transport of limestone in Japan, from the mine to the calcination plant, is assumed to be 20 km, on the road. The burnt lime is then transported by boat from Japan to the Bayer plant in Australia. The distance is estimated to 6500 km.

(2b) NaOH production includes rocksalt mining, the transport of the rocksalt to the NaOH production plant and the diaphagm process.

Rock salt mining
It takes place in the USA. No data on emission is included in this activity. Transport to the NaOH production plant is included.

NaOH is produced in the USA by the diaphagm process. It is transported to the Bayer plant in Australia by boat and the distance is estimated to 30000 km.

(3) Prebake electrolysis or Söderberg electrolysis. Prebake anode production (see section

3a), Aluminium fluoride production (see section 3b) and Cathode production (see section 3c) are used in the Prebake electrolyses. Aluminium fluoride, coal tar pitch, petrolium coke and cathodes are used in the Söderberg electrolysis.

The aluminium production takes place at Hydro Aluminium, Norge.

The production is based on virgin aluminium oxide, bought on the open market. Aluminium oxide and prebake anode is transported from the Bayer process in Australia to Hydro Aluminium in Karmoy, Norway. The distance is estimated to 30000 km and the means of transport is boat.

The main process for producing pure aluminium is electrolyses, where the aluminium oxide is reduced to liquid aluminium in a sequence of electrolysis baths. At Karmoy, two processes are used; the older Söderberg and the more modern prebake process. The anode paste for the Söderberg process is produced at Karmoy. Half of the yearly production comes from the Söderberg process and the other half is from the prebake process.

Raw materials for the electrolyses are aluminium oxide, carbon anodes, aluminium fluoride and cathode materials. The electrolysis bath consists of cryolite ($AlF_3 \cdot 3NaF$), that is formed in the reaction between sodium oxide (Na_2O) and aluminium fluoride (AlF_3).

(3a) Prebake anode production includes coal tar pitch production and petrolium coke production. Coal tar pitch production includes crude tar production and the transport of tar to the coal tar pitch production plant. Petroleum coke production includes crude oil extraction, coking and hydrogenation, calcination of green coke and the transport of heavy oil to the coke plant and calcination.

The anode for the Prebake-process is produced in Rotterdam by Aluchemie and imported to Norway. The transport distance of coal tar pitch and petroleum coke has been assumed to 300 km and the mode of conveyance to be road.

Coal tar pitch production

Coal tar pitch production includes crude tar production and the transport of tar to the coal tar pitch production plant.

Suppliers of coal tar pitch to Karmoy in Norway are three different companies in Denmark, Germany and Great Britain. In this study site-specific data from Tarconord A/S in Nyborg, Denmark has been used. The production is made in three steps; one dewatering step and two extraction steps.

Crude tar
Coal tar pitch is made from crude tar, a by-product from the coke production. The crude tar used at Tarconord A/S is mainly bought from steel works around the world. Data from SSAB Tunnplåt in Luleå, Sweden is used. Crude tar is transported from steel works around the world to Tarconord A/S in Nyborg, Denmark. The transport distance is estimated to 990 km by Per Bech, the environmental manager at Tarcord.

Petrolium coke production

Petrolium coke production includes crude oil extraction, coking and hydrogenation, calcination of green coke and the transport of heavy oil to the coke plant and calcination.

Petroleum coke is produced from heavy oil fraction from refineries by the Söderberg process, at Karmoy, Norway. The petroleum coke is mainly bought from Statoil in Mongstad, Norway but is also imported from Great Britain, Germany and the USA.

Crude oil extraction
Statoil in Mongstad uses crude oil extracted in the North Sea in their production. In this study energy use and emission for crude oil refining to heavy oil are included. The heavy oil is transported from the refineries to Statoil in Mongstad, Norway. The distance is assumed to be 1000 km.

Coking and hydrogenation
The heavy oil is coked and hydrogenated in a multi output process. In this processes five products are produced. The products have the following weight percentages of the total production in the two processes:
- gas 11%
-nafta 11%
-light gas oil 50%
-heavy gas oil 11%
-green coke 17%.

Calcination of green coke
The heaviest fraction in the petroleum coke production, the green coke, is further calcinated and becomes petroleum coke.

(3b) Aluminium fluoride production includes the transport of CaF_2 and aluminium hydroxide to the aluminium production plant.

CaF_2 mining
CaF_2 is mined in Morocco, China and Mexico. The CaF_2 is transported from Morocco to the aluminium fluoride producer by boat (assumption). Further it is assumed that the production of aluminium takes place in northern Europe, wich gives a distance of 4000 km.

	Aluminium hydroxide The aluminium hydroxide is transported to aluminium fluoride producers, a distance assumed to be 1500 km, by boat. The production, called the dry process, is performed in three steps. First, aluminium hydroxide (Al(OH)2) is heated and activated to aluminium oxide(Al2O3). The first reaction is between calcium fluoride and (CaF2) and sulphuric acid (H2(SO)4). Formed products are fluohydric acid (HF) and anhydrite gypsum (Ca(SO)4) as a by-product. Oil is assumed to be used for heating. In the third step fluohydric acid reacts with aluminium oxide (Al2(O3)) and forms aluminium fluoride (AlF3), water and heat. (3c) Cathode production includes steel production, carbon piece production, production of insulation stone and production of fire proof stone. The transport of steel, insulation stone, fireproof stone and carbon pieces to the cathode production plant and the transport of coal tar pitch and petroleum coke to the plant where the carbon pieces are produced, are also included. Steel production Data is taken from SSAB Tunnplåt in Luleå, Sweden. The steel is assumed to be transported on the road from SSAB Tunnplåt in Luleå, Sweden to Hydro Aluminium in Karmoy, Norway and the distance is estimated to 1600 km. Carbon piece The transport of coal tar pitch from unknown supplier to the carbon piece producer is assumed to be done on the road, about 300 km. The same is assumed for petroleum coke. Hydro Aluminium buys their carbon pieces from Germany, France or Japan. The carbon pieces are transported from Germany, France and Japan to Hydro Aluminium in Karmoy, Norway. A mean value of the three distances (one third from each producer) is 1000 km. The mode of conveyance is assumed to be boat. Production of insulation stone Insulation stone is produced in Denmark or Italy. The insulation stone is transported from Denmark and Italy to Hydro Aluminium in Karmoy, Norway. A mean value gives 400 km by boat and 900 km by road. Production of fire proof stone Fired proof stone is produced in Norway, Scotland and two places in Germany. The transport distance for fire proof stone, from Norway, Scotland and the two places in Germany to Hydro Aluminium in Karmoy, Norway, is a mean value of the four distances. The mode of conveyance is assumed to be boat (650 km) from Germany and Scotland and road by (75 km) within Norway.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: This study includes environmental loadings such as material resources, resources for energy production, waste and emissions to air and water. Cradle = Mine.
Time Boundary	APPLICABLE TIME OF SYSTEM/PRODUCT: This set of data is more recent than earlier studies when it comes to several of the processes. Bauxite mining and aluminium oxide production are the exceptions, where old data has been used.
Geographical Boundary	GEOGRAPHICAL EXTENSION The data represent production sites in Norway.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: Production of capital goods, transport of labour and so called overhead processes are not included in this study. The following parameters are not traced back to the cradle: H2SO4, insulation stone, fire proof stone, emulsifier. Insulation stone Insulation stone is produced in Denmark or Italy, but the production process is not included in this study. Fire proof stone Fired proof stone is produced in Norway, Scotland and two places in Germany, but the production process is not included in this study. Cathode production The cathode production takes place at Hydro Aluminium in Karmoy, Norway. No data on environmental loadings are known and therefore it is not included in this study.

Allocations	PRINCIPLE APPLIED: DESCRIPTION: Crude tar production An allocation on mass basis is made. 2,87% of the environmental load is allocated to tar production. Production of coal tar pitch The production of coal tar pitch during a year is 45% by weight of the total production at Tarconord. An allocation is made on mass basis by Per Bech, environmental manager at Tarconord. Production of aluminium fluoride All environmental loads are allocated to aluminium fluoride. Most of the anhydrite gypsum is used as landfill. Production of ammonium nitrate For the production of ammonium nitrate, the raw materials nitric acid and gaseous ammonia are used. The energy used in the production is divided between the products by an allocation on mass bases.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	1996-05-01
Data Type	Unspecified
Represents	See 'Function'.
Method	Excerpt from the publication (see 'Publication'): ''In this study, the necessary information was gathered from producing companies, authorities and the literature, including other LCA studies.''
Literature Reference	Life Cycle Assessment of Aluminium, Copper and Steel by Maria Sunér; Chalmers University of technology; Technical environmental planning; Report 1996:6; Göteborg; Sweden
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Alloy material	65.4			mg	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Bauxite	4920			g	Ground	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Bentonite	50.4			mg	Ground	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Calcium fluoride	48.5			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Chalice	0.303			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Coal	13.8			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Coal	186.6			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Dolomite	0.123			mg	Other	

Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Feldspar	90.8			ug	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Hydro power	52.6			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Iron ore	14.7			g	Ground	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Lime	0.175			mg	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Limestone	883			g	Ground	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Natural gas	40.4			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Oil	1.33			kg	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Olivine	0.32			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Peat	4.18			mg	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Sand	1			mg	Ground	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Sodium sulphate	3.2			mg	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Uranium ore	1.01			mg	Ground	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Natural resource	Water	17.9			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Diesel	0.521			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Electricity	0.0601			MJ	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Emulsifier	1.98			mg	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Fire proof stone	5.22			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	H2SO4	58.6			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Insulation stone	8.7			g	Technosphere	

Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Portland soda	0.143			mg	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Renewable energy source	0.0601			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Input	Refined resource	Solvey soda	0.143			mg	Technosphere	
	Input	Refined resource	Unspecified	4920			g	Technosphere	
	Input	Refined resource	Unspecified	74.2			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Al	13.8			ug	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Aldehydes	1.8			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	As	1.68			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	As	61.5			ng	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	BOD	1.58			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cd	0.308			ng	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cd	73.7			ng	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	CH3	0.113			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cl	4.83			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cl2	42.3			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	CO	1.942			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Co	22.5			ng	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Co	46.1			ng	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	CO2	4737			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	COD	37.2			g	Water	

Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cr	0.478			ug	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cr	3.34			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cu	1.08			ug	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Cu	3.21			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Fe	0.14			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Fe	1.05			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Fluoride	6.87			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	F-tot	0.431			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	F-tot	1.65			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	HC	3.09			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	HCl	0.29			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	HF	0.389			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Hg	0.577			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Inert chemicals	0.219			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Lignin	0.152			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Mn	0.173			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Mn	26.3			ug	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	N2O	50.43			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NaCl	15.2			ug	Water	

Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NH3	0.426			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NH3	0.429			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NH4	1.36			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NH4-N	0.54			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NH4NO3	0.352			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NH4NO3	96.3			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Ni	1.44			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Ni	1.76			ug	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NO3-N	0.493			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	NOx	12.332			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	N-tot	10.4			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Oil	23.72			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Oil	4.84			ug	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	PAH	60.1			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Particulates	28.451			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Pb	0.21			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Pb	3.54			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Phenol	0.292			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	P-tot	8.54			ug	Water	

Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Radon-222	0.165			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Salt waste	3.25			ug	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	SO2	26.03			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	SO2	8.3			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	SO4	9.85			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	SOx	6.41			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Susp solids	0.46			g	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Tar	0.31			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	THC	0.115			g	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	TOC	80			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Tot-CN	6.56			ug	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	V	2.89			ug	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Willow	0.138			mg	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	VOC	1.2			mg	Air	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Zn	1.64			ug	Water	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Emission	Zn	28.9			ug	Air	
	Output	Product	Aluminium	1			kg	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Anhydrite waste	60.1			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Ashes	1.1			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Brick scrap	11.4			mg	Other	

Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Dust	192			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Electrolysis bath	11			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Hazardous waste	2.13			g	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Highly active rad ac waste	34.1			ng	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Medium active rad ac waste	0.181			ug	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Mineral waste	10			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Mixed waste	7.61			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Radioactive waste	0.292			mg	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Recyclable waste	8.62		0	mg	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Redmud	3.42			mg	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Scrap	30.6			mg	Technosphere	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Stone	11			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Waste	61.217			g	Other	
Notes: This metadata id was automatically generated 2007-11-21 as it was previously missing in SPINE@CPM	Output	Residue	Waste containing explosives	0.615			mg	Other	

About Inventory

Publication	Life Cycle Assessment of Aluminium, Copper and Steel, Maria Sunér, Technical Environmental Planning, Report 1996:6 , Chalmers University of Technology, Gotherburg, Sweden -- Data documented by: Maria Erixon, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Anyone who wants to make an Li
General Purpose	To make a life cycle assessment of aluminium, copper and steel.
Detailed Purpose	The data is presented in the report Life Cycle Assessment of Aluminium, Copper and Steel. The purpose of the report was to collect and present inventory data on production and recycling of the three materials aluminium, copper and steel of higher quality than earlier published data.
Commissioner	
Practitioner	Sunér, Maria - Teknisk Miljöplanering Chalmers Tekniska Högskola 412 96 Göteborg Sweden.

Reviewer	
Applicability	CERTAIN CAUTIONS: Almost all data is site-specific and therefore it is not directly applicable in LCA:s requiring average data for metal production.
About Data	GENERAL DATA SOURCE DESCRIPTION: The data represent production sites in Norway. This set of data is a mixture of litterature data and site specific data. -- Production of explosives About 1,4% of the produced Kimlux is packed into plastic pipes and sold as Kimlux 42/82 and the rest is sold in tanks as Kimlux R. In this study all production is assumed to be Kimlux R. Mineral oil The production of mineral oil is approximated to the production of fuel oil. Glass microballs Literature data has been used for production of glass from virgin raw materials, from Packaging and the environment, Tillman A-M et al., Chalmers Industriteknik, Göteborg; Sweden (1992). Petroleum coke production In this study, data from Statoil in Mongstad is used. As Statoil in Mongstad does not produce enough of heavy oil in their refinery, the main part is bought from other refineries. Crude oil extraction It is assumed that the refining of crude oil to heavy oil only consumes 10% of the energy used for gasoline refining. Production of coal tar pitch The production of coal tar pitch during a year is 45% by weight of the total production at Tarconord. Anode production for Prebake The data used for this process is literature data. Aluchemies suppliers is not known. The Prebake anode consists of 85% petrolium coke and 15% coal tar pitch. Aluminium fluoride production Raw materials for aluminium fluoride production are CaF_2, $Al(OH)_3$ and H_2SO_4. Hydro Aluminiums main supplier is not known. Data used in this study is a common known average from several aluminium fluoride suppliers. CaF_2 mining The environmental load for CaF_2 mining has been approximated with the environmental load for limestone mining. Production of $H_2(SO)_4$ $H_2(SO)_4$ is often a by-product from other productions and is therefore treated as an inflow not traced back to the cradle. The transport is excluded. Carbon piece production As no data for this production are available, data for anode production is assumed to be valid. It is also assumed that the raw material distribution are 50% coal tar pitch and 50% petrolium coke. Production of insulation stone As no data are available the insulation stone is an inflow not traced back to the cradle. It is assumed that half of Hydro Aluminium's need is purcased from each producer. Production of fire proof stone As no data are available, fire proof stone is considered to be an inflow not traced back to the cradle. It is assumed that one fourth of Hydro Aluminium's need is purcased from each producer. Cathode production The cathode production takes place at Hydro Aluminium in Karmoy, Norway. No data on environmental loadings are known and therefore it is not included in this study. Aluminium production The main source of the data is Per Ravn, Environmental and security manager at Hydro Aluminium in Karmoy, Norway. The production is based on virgin aluminium oxide, bought on the open market. There are many suppliers. Hydro Aluminium owns parts of an aluminium oxide plants on Jamaica and Guine wich cover 40% of their need.

	The prebake process has prebakes anodes and generates less emissions, especially CF4, than the Söderberg process. It is also a process with with more automation and less heat losses. The sodium oxide is found as an impurity (0,5%) in the aluminium oxide. In average 11% AlF3 is added to th electrolysis bath. Emissions of fluorine and fluorides originates mainly from the electrolysis. The fluorides consist of HF, particulate fluorides and some CF-gases (95% CF4 and 5% C2F6). The anode is booked as a resource at the extraction of the needed raw materials and not as an internal energy carrier. However the anode contributes with energy to the process. The casting of ingots is included in this activity.
Notes	

SPINE LCI dataset: Virgin steel production

Administrative	
Finished	Y
Date Completed	1996-05-01
Copyright	
Availability	Public.

Technical System	
Name	Virgin steel production
Functional Unit	kg
Functional Unit Explanation	Inventory result for production of 1 kg virgin steel.
Process Type	Cradle to gate
Site	
Sector	Materials and components
Owner	
Technical system description	The steel production is situated at SSAB Tunnplåt in Luleå, Sweden. Mainly virgin raw material is used, in the form of iron ore pellets, distributed at LKAB in Malmberget, Sweden. The production of explosives (Kimulux R), used in limestone mining for steelproduction, at Kimit AB is also included. -- (1) Iron ore pellet production at LKAB Explosives is transported to the Olivine and Iron ore mining. The production of explosives is included, see section (3) below. The iron goes through the processes of Dressing, Concentration, Pelletising to finally become iron pellets. The olivine is transported from the olivine mining to the concentration process. Bentonite is transported from the bentonite mining to pelletising process. (2) Steel production at SSAB Tunnplåt In the main process steps the iron pellets from LKAB are transported to the Blast furnace, where limestone and coal are added, and then goes through the processes at the Steel work. Explosives are transported to the Limestone mining (at Nordkalk Storugns on the island of Gotland in Sweden), and the mined limestone further partly to the Blast furnace and partly to the Limestone oven. From the Limestone oven the lime is added in the Steel work, together with Aluminium and Alloy materials. Coal, from the Coal mining, is transported partly straight to the Blast furnace and partly via the Coke plant.

	(3) Production of explosives (Kimulux R) at Kimit AB The raw materials Sodium nitrate (3.1), Ammonium nitrate (3.2), (together 85% of the raw materials), Mineral oil (3.3), Microballoons (3.4), Emulsifier (3.5) and Aluminium powder (3.6) are transported to the Explosives production plant at Kimit AB in Kiirunavara in Sweden, wher Kimulux R is produced. (3.1) Sodium nitrate production Sodium nitrate is produced through extraction from a nitrate mineral called chalice. Chalice is find and mined in Chile, were also the sodium nitrate is refined. The sodium nitrate contents in the mined mineral is about 7%. The produced sodium nitrate is imported to Sweden via Antwerp in the Netherlands. It is transported by boat 15 400 km, from Chile to Gothenburg via Antwerp and by road 1580 km, from Gothenburg to Kiruna. (3.2) Ammonium nitrate production For the production of ammonium nitrate, nitric acid and gaseous ammonia are used. The production takes place at Dyno Nitrogen in Ljungaverk, Sweden, and it includes the Extraction of natural gas, Transport to the Ammonia production and further Transport partly straight to the Ammonium nitrate production and partly via NHO3-production. The production of nitric acid starts with gasification of compressed ammonia. Air is added and the mixture is heated in purpose to oxidise the ammonia to nitrogen oxides. The process gases are cooled and led to an absorption tower. The nitrogen oxides are absorbed and reacts with water to nitric acid. 19,7% of the produced nitric acid is sold, the rest is used for the ammonium nitrate production. The ammonia is bought from Hydro Agri in Landskrona, Sweden. Hydro Agri imports ammonia from Ukraine. The transport of ammonia from Ukraine to Dyno Nitrogen in Ljungaverk, Sweden, with a stop at Hydro Agri in Landskrona, Sweden, is assumed to be done by train. The distance is estimated to 3400 km. Ammonium nitrate production is carried out by mixing a 54% solution of nitric acid with gaseous ammonia in a reactor. Ammonium nitrate is formed in an exothermic reaction. The product is sold in liquid, crystalline or in pilled form. The ammonium nitrate is transported 866 km (estimated) by road, from Ljungaverk to the explosives production plant in Kiirunavara, Sweden. (3.3) Mineral oil production The production of mineral oil is approximated to the production of fuel oil and includes the Extraction of crude oil, Transport and Refinery. The mineral oil is produced by Mobil in Uddevalla, Sweden, and is transported 1540 km (estimated) by road to Kiruna, Sweden. (3.4) Microballoon production The microballoons are produced by MMM in France. They are transported 3000 km (estimated) by road to Kiruna, Sweden. (3.5) Emulsifier The production of emulsifier is excluded. The transport of emulsifier is included and assumed to be 300 km, by road. (3.6) Aluminium powder production Aluminium powder is imported from Germany, Italy or Switzerland, but data has been used from the production of aluminium at Hydro Aluminium in Karmoy, Norway. The transport distance for aluminium powder is a mean value of the distance from Germany, Italy and Switzerland to Kiruna, Sweden, and is estimated to 3000 km. Electricity production is included.

System Boundaries	
Nature Boundary	Emissions to air and water, waste and natural resources.
Time Boundary	The data is collected during the early nineties and one should consider some change i process steps etc. as times go.
Geographical Boundary	Most of the processes takes place in Sweden, except for the production of microballoons wich takes place in France. The chalice is mined in Chile, the aluminium powder is imported from Germany, Italy or Switzerland and the ammonia from Ukraine.
Other Boundaries	The production of emulsifier is excluded from this study and it is a minor inflow. The emulsifier is treated as an inflow not traced back to the cradle.

Allocations	All environmental impact is allocated to the steel production (at SSAB Tunnplåt in Luleå, Sweden). - Production of explosives (Kimulux R) at Kimit AB 92,8% (by weight) of the total production at Kimit AB 1994 was Kimulux R. This allocation factor is used for the environmental loadings.
Systems Expansions	No.

Flow Data

General Activity QMetaData

Date Conceived	1996-05-01
Data Type	Derived, unspecified
Represents	See 'Function'.
Method	Excerpt from the publication (see 'Publication'): ''In this study, the necessary information was gathered from producing companies, authorities and the literature, including other LCA studies.''
Literature Reference	Life Cycle Assessment of Aluminium, Copper and Steel; Maria Sunér; Report 1996:6; Technical Environmental Planning; Chalmers University of Technology; Göteborg; Sweden
Notes	Not applicable.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Natural resource	Alloy ore	17.9			g	Other	
	Input	Natural resource	Bauxite	9.67			g	Other	
	Input	Natural resource	Bentonite	8.69			g	Other	
	Input	Natural resource	Chalice	2.23			g	Other	
	Input	Natural resource	Coal	13.0			g	Other	
	Input	Natural resource	Coal	725			g	Other	
	Input	Natural resource	Diesel	69.9			mg	Other	
	Input	Natural resource	Dolomite	0.902			mg	Other	
	Input	Natural resource	Electricity	1.27			kJ	Other	
	Input	Natural resource	Emulsifier	14.5			mg	Other	
	Input	Natural resource	Feldspar	0.667			mg	Other	
Notes: 4,29 g is a resource for electricity production and 1,47 g for precombustion.	Input	Natural resource	Fuel oil	60.1			g	Other	
	Input	Natural resource	Hydro power	0.906			g	Other	
	Input	Natural resource	Iron ore	2750			g	Other	
	Input	Natural resource	Lime	1.28			mg	Other	
	Input	Natural resource	Limestone	130			g	Other	
	Input	Natural resource	Na2SO4	23.5			mg	Other	
	Input	Natural resource	Natural gas	0.818			g	Other	
Notes: 2,27 g is a resource for electricity production and the rest for precombustion.	Input	Natural resource	Natural gas	5.40			g	Other	
	Input	Natural resource	NO3-N	60.2			g	Other	
	Input	Natural resource	Oil	1.16			g	Other	

	Input	Natural resource	Peat	0.712			g	Other	
	Input	Natural resource	Portland soda	1.05			mg	Other	
	Input	Natural resource	Renewable energy source	3.93			g	Other	
	Input	Natural resource	Sand	7.36			mg	Other	
	Input	Natural resource	Solvey soda	1.05			mg	Other	
	Input	Natural resource	Uranium	1.06			mg	Other	
	Input	Natural resource	Water	2.68			g	Other	
	Output	Emission	Al	0.725			mg	Water	
	Output	Emission	Aldehydes	0.245			mg	Air	
	Output	Emission	As	0.173			mg	Air	
	Output	Emission	As	2.50			ug	Water	
	Output	Emission	BOD	14.4			ug	Water	
	Output	Emission	Cd	12.7			ug	Air	
	Output	Emission	Cd	53.2			ng	Water	
Notes: 0,232 mg is emitted from the electricity production.	Output	Emission	CH4	3.29			g	Air	
Notes: 1,64 ug is emitted to water from the electricity production.	Output	Emission	Chloride	0.256			mg	Water	
Notes: 37,6 mg is emitted from the electricity production.	Output	Emission	CO	0.322			g	Air	
	Output	Emission	Co	3.87			ug	Water	
	Output	Emission	Co	7.97			ug	Air	
Notes: 49,5 g is emitted from the electricity production.	Output	Emission	CO2	1210			g	Air	
Notes: 43,5 ug is emitted to water from the electricity production.	Output	Emission	COD	38.2			mg	Water	
	Output	Emission	Cr	0.429			mg	Air	
	Output	Emission	Cr	45.5			ug	Water	
	Output	Emission	Cu	0.126			mg	Water	
	Output	Emission	Cu	0.201			mg	Air	
	Output	Emission	Dissolved solids	30.9			mg	Water	
	Output	Emission	Fe	0.174			g	Air	
Notes: 0,291 ug is emitted to water from the electricity production.	Output	Emission	Fe	7.25			mg	Water	
	Output	Emission	Fluorides	0.131			mg	Water	
	Output	Emission	Fluorides	0.971			ug	Air	
Notes: 0,208 g is emitted from the electricity production.	Output	Emission	HC	0.423			g	Air	
	Output	Emission	HCl	49.9			mg	Air	
	Output	Emission	HF	67.2			mg	Air	
	Output	Emission	Hg	99.6			ng	Air	
	Output	Emission	HNO3	35.5			ug	Water	
	Output	Emission	Mn	29.9			ug	Air	
	Output	Emission	Mn	3.55			mg	Water	
Notes: 7,59 mg is emitted from the electricity production.	Output	Emission	N2O	8.56			mg	Air	
	Output	Emission	Na+	21.4			ug	Water	
	Output	Emission	NaCl	0.111			mg	Water	
Notes: 50,2 ug is emitted from the electricity production.	Output	Emission	NH3	1.20			mg	Air	
Notes: 60,2 ug is emitted to water from the electricity production.	Output	Emission	NH3	78.7			ug	Water	
	Output	Emission	NH4-N	8.91			mg	Water	
	Output	Emission	NH4NO3	0.708			mg	Air	
	Output	Emission	NH4NO3	2.59			mg	Water	
	Output	Emission	Ni	0.110			mg	Water	
	Output	Emission	Ni	0.249			mg	Air	
	Output	Emission	NO2-N	0.562			mg	Water	
Notes: 0,136 g is emitted from the electricity production.	Output	Emission	NOx	2.07			g	Air	
Notes: 0,453 ng is emitted to water from the electricity production.	Output	Emission	N-tot	41.5			mg	Water	

Notes: 0,469 mg is emitted to water from the electricity production.	Output	Emission	Oil	1.83			mg	Water	
Notes: 30,8 ug is emitted to water from the electricity production.	Output	Emission	Olivine	3.64			mg	Water	
	Output	Emission	PAH	0.208			mg	Air	
Notes: 19,3 mg is emitted from the electricity production.	Output	Emission	Particles	1.94			g	Air	
	Output	Emission	Pb	0.486			mg	Water	
	Output	Emission	Pb	0.612			mg	Air	
Notes: 0,0134 ng is emitted to water from the electricity production.	Output	Emission	Phenol	0.168			mg	Water	
	Output	Emission	P-tot	0.506			mg	Water	
	Output	Emission	Radon-222	8.704			kBq	Air	
Notes: 0,256 g is emitted from the electricity production.	Output	Emission	SO2	2.80			g	Air	
Notes: 27,4 ug is emitted to water from the electricity production.	Output	Emission	SO4 2-	0.363			g	Water	
	Output	Emission	SOx	0.421			g	Air	
	Output	Emission	Sr	7.25			mg	Water	
Notes: 14,4 ug is emitted to water from the electricity production.	Output	Emission	Susp solids	11.8			mg	Water	
	Output	Emission	Tot-CN	0.339			mg	Water	
	Output	Emission	V	0.467			mg	Air	
	Output	Emission	Zn	0.107			mg	Water	
	Output	Emission	Zn	4.29			mg	Air	
	Output	Product	Steel	1			kg	Technosphere	
Notes: 0,116 g is waste from the electricity production.	Output	Residue	Ashes	0.119			g	Other	
	Output	Residue	Hazardous waste	2.11			mg	Other	
Notes: This is waste from the electricity production.	Output	Residue	Highly active rad ac waste	0.251			ug	Other	
Notes: This is waste from the electricity production.	Output	Residue	Medium active rad ac waste	1.33			ug	Other	
Notes: Explosive remains 4,53 mg Dust 0,376 g LD-secondary dust 0,594 g Sludge 5,55 g Redmud 6,72 g Non-magnetic waste 20,1 g LD-sludge 26,9 g LD-slag 34,2 g	Output	Residue	Other rest products	94.4			g	Other	
Notes: This is waste from the electricity production.	Output	Residue	Radioactive waste	49.7			mg	Other	
Notes: Brick scrap 5,28 g.	Output	Residue	Scrap	7.25			g	Other	
	Output	Residue	Waste	1280			g	Other	

About Inventory

Publication	Life Cycle Assessment of Aluminium, Copper and Steel; Maria Sunér; Technical Environmental Planning; Report 1996:6; Chalmers University of Technology; Gothenburg; Sweden --- Data documented by: Maria Erixon, project employed at Technical Environmental Planning, Chalmers University of Technology Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	A Life Cycle Assessment practi
General Purpose	To make an LCA for Al, Cu and steel.
Detailed Purpose	The data is presented in the report Life Cycle Assessment of Aluminium, Copper and Steel. The purpose of the report was to collect and present inventory data on production and recycling of the three materials aluminium, copper and steel of higher quality than earlier published data.
Commissioner	
Practitioner	Sunér, Maria - Teknisk Miljöplanering Chalmers Tekniska Högskola 412 96 Göteborg Sweden.
Reviewer	
Applicability	

About Data	- Production of explosives (Kimulux R) at Kimit AB Ammonium nitrate production Data for the extraction of natural gas is valid for the North Sea, but it is also assumed to be valid for Ukraine. The data is litterature data. All oil is assumed to be used in the production of nitric acid. All electricity used in the ammonium nitrate production is assumed to be used in the process of mixing nitric acid with ammonia and all emissions that are not from any specific process are accounted for here. The oil accounted for is the resource for the used transformer oil. Glass microballoon production Since no data were available, literature data has been used for the production of glass.
Notes	

SPINE LCI dataset: Wood chips fired plant (with stoker) for heat and power production - Large plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Wood chips fired plant (with stoker) for heat and power production - Large plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a wood chips fired plant with stoker for heat and power production located in Sweden. The heat is delivered to a district heating net. Production of materials, chemicals and electricity, transport, used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): 5 598 Total electric output (MW): Not known. Only given as the total of three boilers. Total thermal output (MW): 78+13 Annual total fuel use (MWh): 319 031 Normal annual production of heat (MWh): 297 406 Normal annual production of electricity (MWh): 30 195 Degree of thermal efficiency (%): 102,7 PROCESS DESCRIPTION: The plant consists of a steam boiler unit of 80 MW thermal output with a flue gas condensing system of 13 MW thermal output. Electricity is produced in three turbines that are common for three boilers. The solid fuel is combusted on a grate. The grate can be moving or sloping. The fuel is fed to one end of the grate and during the combustion transported to the other side. At the end of the grate the ashes is taken out. Air is added both through the bed and as over-fire air

	higher up in the combustion chamber to complete the combustion. The dust is removed from the flue gas in an electrostatic precipitator. INCLUDED OPERATIONS: The process of study consists of the following operations: - The feeding of the pulverized wood into the combustion process. - The combustion process. - The removal of dust from the flue gas in the electrostatic precipitator. - The internal treatment of the residues from the combustion process. - The internal consumption of electricity. - The internal consumption of chemicals used in the flue gas system and in the feed water treatment. - The NOx control system. NOx CONTROL: The boiler is equiped with a SNCR process for lower NOx emissions. Urea is used as reducing agent. SNCR (Selective Noncatalytic Reduction) describes a method for reducing the NOx already formed during the combustion process. In the process, an aqueous reduction agent mixed in water or steam is injected into the furnace during the combustion process. The reduction agent reduces the NOx and forms nitrogen and water. OTHER FLUE GAS CLEANING SYSTEMS: - For the removal of dust from the flue gas an electrostatic precipitator is used. In an electrostatic precipitator the dust particles are electrified and then separated from the flue gas stream by passing through an electric field with largest possible intensity. - Due to the low sulphur content in wood fules, no reduction of the sulphur content in the flue gas is needed.

System Boundaries	
Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. The emission of HC is not measured.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION This inventory has been conducted on a wood chips fired plant with stoker for heat and power production in Sweden, with swedish regulations, applicable during 1996. The collected data should be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Buildning of the plant and the district heating net. - The cradle to gate of the internal electricity consumption. - The production of the pulverized wood fuel. - The transportation of the fuel to the plant. - The transportation of the residues from the combustion and cleaning processes to the landfill or back to the forest. - The process at the landfill such as leaching, decomposition etc. - The spreading of the ashes in the forest. EXCLUDED FLOWS - The water consumption in the process.
Allocations	PRINCIPLE APPLIED: In a combined power and heating plant two products of economic value are produced, heat and electrical power. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat and power respectively. For the use of resources and the emissions that are specific for the electrical power production are allocated to that production. Equivalent to this the use of resources and the emissions specific for the heat production are allocated to this production. Note: When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power. DESCRIPTION:
Systems Expansions	N/A

Flow Data	
General Activity QMetaData	
Date Conceived	1996

Data Type	
Represents	See 'Function'.
Method	All data reported is related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amount of an input (fuel, chemical, electricity etc.) to or an output (emission, product etc.) from the energy plant. The inputs and outputs are the related to the functional unit by dividing the total yearly amount with the yearly amount of produced heat and multiplying with the fraction of the total production that are associated with the heat production. For some flows specific information is given, see each flow.
Literature Reference	Data are in general recieved from ''Miljörapport 1996, Tekniska Verken i Linköping''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All data are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: The consumed amount for the year.	Input	Refined resource	Bio fuel	448			g	Technosphere	
Method: Not known.	Input	Refined resource	Electricity	0.05			kWh	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	NaCl	0.00717			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	NaOH	0.00918			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Sodium hypochlorite	0.000717			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Trisodium phosphate	0.000359			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Urea	2.58			g	Technosphere	
Method: Not known.	Output	Emission	CO	0.165			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with biofuels, according to NUTEK. The standard value for biofuels is 114 g/MJ fuel supplied.	Output	Emission	CO2	451			g	Air	
Data type: Single sample Method: This emission is measured once a year at the periodical inspection. The yearly amount of the emission is then estimated from this single sample.	Output	Emission	Dust	0.00855			g	Air	
Data type: Single sample Method: This emission is measured once a year at the periodical inspection. The yearly amount of the emission is then estimated from this single sample.	Output	Emission	N2O	0.0174			g	Air	
Data type: Single sample Method: This emission is measured once a year at the periodical inspection. The yearly amount of the emission is then estimated from this single sample.	Output	Emission	NH3	0.000397			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	NOx	0.167			g	Air	
Method: Not known.	Output	Emission	N-tot	0.0000182			g	Water	
Method: Not known.	Output	Emission	SO2	0.0351			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	
Method: The formed amount of ashes for the year.	Output	Residue	Ashes	5.92			g	Technosphere	
Method: The formed amount for the year.	Output	Residue	Combustible waste	0.0359			g	Technosphere	
Method: The formed amount for the year.	Output	Residue	Noncombustible waste	0.0215			g	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended use of the data are t
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden. This data should only be used on plants producing heat in Sweden and for swedish conditions. When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.
Notes	

SPINE LCI dataset: Wood chips fired plant (with stoker) for heat production - Small plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Wood chips fired plant (with stoker) for heat production - Small plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden

Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system descibes the incineration process in a wood chips fired plant with stoker for heat production located in Sweden. The heat is delivered to a distric heating net. The production of materials, chemicals, electricity and transport, used in association with the fuel chain and operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: The technical data for this system is reported from the final inspection of the plant. Average annual time of use (hours): - Total thermal output (MW): 4 Fuel use during the final inspection (MWh): 4 Production of heat during the final inspection (MWh): 3,51 Degree of thermal output (%)t: 87,8 PROCESS DESCRIPTION: The plant consists of one boiler unit of 4 MW thermal output for heat production. The boiler is fired with wood chips. The solid fuel is combusted on a grate. The grate can be moving or sloping. The fuel is fed to one end of the grate and during the combustion transported to the other side. At the end of the grate the ashes is taken out. Air is added both through the bed and as over-fire air higher up in the combustion chamber to complete the combustion. The dust is removed with multicyclone system. INCLUDED OPERATIONS: The process of study consists of the following operations: - The feeding of the wood chips into the combustion process. - The combustion process. - The removal of dust from the flue gas in the multicyclone system. - The internal treatment of the residues from the combusiton process. NOx CONTROL: The boiler is not equiped with any NOx control system. OTHER FLUE GAS CLEANING SYSTEMS: For the removal of dust from the flue gas a multicyclone is used. Due to the low sulphur content in wood fules, no reduction of the sulphur content in the flue gas is needed.

System Boundaries	
Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are taken from the final inspection of the plant. The emission of HC is not measured.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data mainly from the final performance inspection of the plant. The yearly amount of the emissions was then estimated from this single sample. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION: This inventory has been conducted on a wood chips fired plant with stoker for heat production in Sweden, with swedish regulations, applicable during 1997. The collected data should be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the internal electricity consumption. - The production of the wood chips. - The transportation of the fuel to the plant. - The transportation of the residue from the combustion and cleaning processes to the landfill or back to the forest. - The process at the landfill such as leaching, desomposition etc. - The spreading of the ashes in the forest. EXCLUDED FLOWS - The water consumption in the process. - The chemicals used for feed water treatment.
Allocations	PRINCIPLE APPLIED: In a heating plant one product of economic value are produced, heat. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	97-03-25
Data Type	
Represents	See 'Function'.
Method	All data reported is related to the functional unit 1 kWh produced and delivered heat. The data is originally given as the average value for one hour of an input (fuel, chemical, electricity etc.) to or an output (emission, product) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the average amount with the amount of produced heat during average value for one hour. For some flows specific information is given, see each flow.
Literature Reference	Data are taken from the final inspection of the plant, 1997.
Notes	The parameters that are presented are chosen because they were presented in the report from the final inspection of the plant. Data can be missing if it is not reported in the report. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
Method: The consumed amount for the year.	Input	Refined resource	Bio fuel	435			g	Technosphere	
Method: Not known.	Input	Refined resource	Electricity	0.05			kWh	Technosphere	
Method: This emission was measured at the final inspection of the plant, the performance inspection. The yearly amount of the emission was then estimated from this single sample. Literature: The final inspection, Performanse inspection.	Output	Emission	CO	0.308			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with biofuels, according to NUTEK. The standard value for biofuels is 114 g/MJ fuel supplied	Output	Emission	CO2	467			g	Technosphere	
Method: This emission was measured at the final inspection of the plant, the performance inspection. The yearly amount of the emission was then estimated from this single sample. Literature: Final inspection, Performance inspection.	Output	Emission	Dust	0.133			g	Air	
Method: This emission was measured at the final inspection of the plant, the performance inspection. The yearly amount of the emission was then estimated from this single sample. Literature: Final inspection, Performance inspection.	Output	Emission	NOx	0.258			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	
Method: The formed amount for the year.	Output	Residue	Ashes	6.14			g	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.

Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from the final, performance inspection of the plant in 1997. The yearly amounts of the emissions were then estimated from this single sample. This data is assumed to be valid until new national or local regulations are inforced in Sweden. This data should only be used on plants producing heat in Sweden an for swedish conditions.
About Data	GENERAL DATA SOURCE DESCRIPTION: The emissions from plants with a thermal output of <10 MW are often based on few measurements for example the final inspection of the plant or the periodical inspection.
Notes	

SPINE LCI dataset: Wood fired CFB plant for heat and power production - Large plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Wood fired CFB plant for heat and power production - Large plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a wood fired CFB (Circulating Fluidised Bed) plant for heat and power production. The plant is located in Sweden and is fired with wood. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): 6174 Total electric output (MW): 9 Total thermal output (MW): 27+6 Annual total fuel use (MWh): 137 872 Normal annual production of heat (MWh): 101 812 Normal annual production of electricity (MWh): 32 301 Degree of thermal efficiency (%): 97,3 PROCESS DESCRIPTION: The plant consists of one unit of 27 MW thermal output with a flue gas condensing system of 6 MW thermal output. The dust is removed from the flue gas in an electrostatic precipitator. INCLUDED OPERATIONS: The process of study consists of the following operations: - The feeding of the wood into the combustion process. - The combustion process.

	- The removal of dust from the flue gas in the electrostatic precipitator. - The internal treatment of the residues from the combustion process. - The internal consumption of electricity. - The internal consumption of chemicals for the feed water treatment. NOx CONTROL: The boiler is not equiped with any NOx control system. The CFB, circulating fluidised bed combustion, is in itself a low NOx technique. OTHER FLUE GAS CLEANING SYSTEMS: - For the removal of dust from the flue gas an electrostatic precipitator is used. In an electrostatic precipitator the dust particles are electrified and then separated from the flue gas stream by passing through an electric field with largest possible intensity. - Due to the low sulphur content in wood fules, no reduction of the sulphur content in the flue gas is needed.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION This inventory has been conducted on a CFB plant for heat and power production in Sweden, with swedish regulations, applicable during 1996. The collected data should be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the internal electricity consumption. - The production of the wood fuel. - The transportation of the fuel to the plant. - The transportation of the residues from the combustion and cleaning processes to the landfill or back to the forest. - The processes at the landfill such as leaching, decomposition etc. - The spreading of the ashes in the forest. EXCLUDED FLOWS - The water consumption in the process.
Allocations	PRINCIPLE APPLIED: In a combined power and heating plant two products of economic value are produced, heat and electrical power. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat and power respectively. For the use of resources and the emissions that are specific for the electrical power production are allocated to that production. Equivalent to this the use of resources and the emissions specific for the heat production are allocated to that production. Note: When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	See 'Function'.
Method	All data reported is related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amount of an input (fuel, chemical, electricity etc.) to or an output (emission, product) from the energy plant. The inputs and outputs are then related to the functional unit by deviding the yearly amount with the yearly amount of produced heat and multiplying with the fraction of the total production that are associated with the heat production. For some flows specific information is given, see each flow.
Literature Reference	Data is in general recieved from ''Miljörapport 1996, Nässjö Energi AB'' and ''Driftstatistik MK14''.

Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. Some additional data are taken from the statistics from the operation of the plant. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: The consumed amount for the year.	Input	Refined resource	Ammonia	0.00552			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Bio fuel	443			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Cyclohexylamine	0.000183			g	Technosphere	
Method: Not known.	Input	Refined resource	Electricity	0.0454			kWh	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Hydrazine	0.000746			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Lubricating oil	0.00574			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	NaCl	0			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	NaOH	0.00224			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Natural sand	0.00224			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Steel	0.0127			g	Technosphere	
Data type: Monitored data, continuous Method: This emission is measured continously.	Output	Emission	CO	0.144			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with biofuels, according to NUTEK. The standard value for biofuels is 114 g/MJ fuel supplied	Output	Emission	CO2	380			g	Air	
Method: Not known.	Output	Emission	Dust	0.0185			g	Air	
Method: Not known.	Output	Emission	HC	0.000000105			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continously.	Output	Emission	NOx	0.27			g	Air	
Method: Not known.	Output	Emission	N-tot	0.0164			g	Water	
Data type: Monitored data, continuous Method: This emission is measured continously.	Output	Emission	SO2	0.0296			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	
Method: The formed amount for the uear.	Output	Residue	Ashes	4.99			g	Technosphere	
Method: The formed amount for the year.	Output	Residue	Other rest products	0.0147			g	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.

Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden. This data should only be used on plants producing heat in Sweden and for swedish conditions. When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.
About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.
Notes	Combined heat and power plants are used as base primarly during the winter half, when the need for heat and power are the largest.

SPINE LCI dataset: Wood fired CFB plant for heat production - Small plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Wood fired CFB plant for heat production - Small plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of recources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a wood chips fired CFB (Circulating Fluidised Bed) plant for heat production. The plant is located in Sweden and is fired with wood chips. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport, used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): 4 071 Total thermal output (MW): 10 Annual total fuel use (MWh): 40 931 Normal annual production of heat (MWh): 36 463

	Degree of thermal efficiency (%): 86,9 PROCESS DESCRIPTION: The plant consists of one unit of 10 MW maximum thermal output. The dust is removed in a cyclone and a textile filter. INCLUDED OPERATIONS: The process of study consists of the following operations: - The feeding of the wood into the combustion process. - The combustion process. - The removal of dust from the flue gas in the cyclone and the textile filter. - The internal treatment of the residues from the combustion process. - The internal comsumption of electricity. NOx CONTROL: The boiler is not equiped with any NOx control system. The CFB, circulating fluidised bed combustion, is in itself a low NOx technique. OTHER FLUE GAS CLEANING SYSTEMS: - For the removal of dust from the flue gas a cyclone and a textile filter are used. The combustion gases with the particles are entering the cyclone at a high speed. In the cyclone the particles are separated from the gas stream by centrifugal acceleration forces. - Due to the low sulphur content in wood fules, no reduction of the sulphur content in the flue gas is needed.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public report.
Time Boundary	APPLICABLE TIME OF SYSTEM): This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION This inventory has been conducted on a wood chips fired CFB plant for heat production in Sweden, with swedish regulations, applicable during 1996. The collected data should be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the internal electricity consumption. - The production of the wood fuel. - The transportation of the fuel to the plant. - The transportation of the residues from the combustion and cleaning processes to the landfill or back to the forest. - The processes at the landfill such as leaching, decomposition etc. - The spreading of the ashes in the forest. EXCLUDED FLOWS - The water consumption in the process. - The chemicals for feed water treatment.
Allocations	PRINCIPLE APPLIED: In a heating plant one product of economic value is produced, heat. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	See 'Function'.
Method	All data reported is related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amount of an input (fuel, chemical, electricity etc.) to or an output (emission, product etc.) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the total yearly amount with the yearly amount of produced heat. For some flows specific information is given, see each flow.
Literature Reference	The data is in general recieved from ''Miljörapport 1996, AB Eksjö Energi''.

Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Method: The consumed amount for the year.	Input	Refined resource	Bio fuel	484			g	Technosphere	
Method: Not known.	Input	Refined resource	Electricity	0.05			kWh	Technosphere	
Data type: Single sample Method: This emission is mesured at the yearly periodical inspection. The yearly amount of the emission is then estimated from this single sample. Literature: Miljörapport 1996, Eksjö Energi AB	Output	Emission	CO	0.276			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with biofuels, according to NUTEK. The standard value for biofuels is 114 g/MJ fuel supplied	Output	Emission	CO2	461			g	Air	
Data type: Single sample Method: This emission is mesured at the yearly periodical inspection. The yearly amount of the emission is then estimated from this single sample. Literature: Miljörapport 1996, Eksjö Energi AB	Output	Emission	Dust	0.318			g	Air	
Data type: Single sample Method: This emission is mesured at the yearly periodical inspection. The yearly amount of the emission is then estimated from this single sample. Literature: Miljörapport 1996, Eksjö Energi AB	Output	Emission	NOx	0.526			g	Air	
Method: Not known.	Output	Emission	N-tot	0.0000164			g	Water	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	
Method: The formed amount for the year.	Output	Residue	Ashes	6.45			g	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. --- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology ---
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden. This data should only be used on plants producing heat in Sweden and for swedish conditions.

About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.
Notes	

SPINE LCI dataset: Wood pellets fired plant for heat and power production - Large plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Wood pellets fired plant for heat and power production - Large plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of resources and raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in a wood pellets fired plant for heat and power production. The plant is located in Sweden and is fired with wood pellets. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: Average annual time of use (hours): 4 826 Total electric output: Not known Total thermal output (MW): 6,8 Annual total fuel use (MWh): 48 611 Normal annual production of heat (MWh): 42 143 Normal annual production of electricity (MWh): 9329 Degree of thermal efficiency (%): 92,0 PROCESS DESCRIPTION: The plant consists of two steam boiler units of 6,8 MW thermal output each. The boilers are of MBC type (Multi Bed Combustion). Dust is removed from the flue gas in a dust filter bag. INCLUDED OPERATIONS: The process of study consists of the following operations: - The feeding of the wood pellets into the combustion process. - The combustion process. - The removal of dust from the flue gas in the electrostatic precipitator. - The internal treatment of the residues from the combustion process. - The internal consumption of electricity. NOx CONTROL: The boilers are not equiped with any NOx control system. The MBC, (Multi Bed Combustion), technique is in itself a low NOx technique.

	OTHER FLUE GAS CLEANING SYSTEMS: - For the removal of dust from the flue gas an electrostatic precipitator is used. Electrostatic precipitation In an electrostatic precipitator the dust particles are electrified and then separated from the flue gas stream by passing through an electric field with largest possible intensity. - Due to the low sulphur content in wood fuels, no reduction of the sulphur content in the flue gas is needed.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are normally measured and reported once yearly in a public environmental report. The emission of HC is not measured.
Time Boundary	APPLICABLE TIME OF SYSTEM/PRODUCT: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden.
Geographical Boundary	GEOGRAPHICAL EXTENSION: This inventory has been conducted on a wood pellets plant fired system for heat and power production in Sweden, with swedish regulations, applicable during 1996. The collected data should be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the internal electricity consumption. - The production of the wood pellets fuel. - The transportation of the fuel to the plant. - The transportation of the residue drom the combustion and cleaning processes to the landfill or back to the forest. - The processes at the landfill such as leaching, decomposition etc. - The spreading of the ashes in the forest. EXCLUDED FLOWS - The water consumption in the process.
Allocations	PRINCIPLE APPLIED: In a combined power and heating plant two products of ecomnimic value are produced, heat and power. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat and power respectively. For the use of resources and the emisssions that are specific for the electrical power production are allocated to that production. Equivalent to this the use or resources and the emissions specific for the heat production are allocated to that production. Note: When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	See 'Function'.
Method	All data reported is related to the functional unit 1 kWh heat produced and delivered. The data is originally given as the total yearly amaount of an input (fuel, chemical, electricity etc. to or an output (emission, product) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the total yearly amount with the yerarly amount of produced heat and multiplying with the fraction of the total production that are associated with the heat production. For some flows specific information is given, see each flow.
Literature Reference	Data is in general recieved from ''Miljörapport 1996, Hallsberg kraft och värme AB''.
Notes	The parameters presented are chosen because they are available in the annual environmental report of the plant. Data can be missing if it is not reported in the report. The type of data reported is governed by the inspection authority. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	Direction	FlowType	Substance	Quantity	Min	Max	Unit	Environment	Geography
Method: The consumed amount for the year.	Input	Refined resource	Bio fuel	265			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Degreasing compound	0.000446			g	Technosphere	
Method: Not known.	Input	Refined resource	Electricity	0.0744			kWh	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Hydrazine	0.00223			g	Technosphere	
Method: The consumed amount for the year.	Input	Refined resource	Lubricating oil	0.00223			g	Technosphere	
Data type: Monitored data, continuous Method: This data is measured continuously.	Output	Emission	CO	0.406			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with biofuels, according to NUTEK. The standard value for biofuels is 114 g/MJ fuel supplied	Output	Emission	CO2	445			g	Technosphere	
Data type: Single sample Method: This emissions are measured once yearly at the periodical inspection. The yearly amount of the emissions are then estimated from this single sample. For some flows specific information is given, see each flow.	Output	Emission	Dust	0.00442			g	Air	
Data type: Monitored data, continuous Method: This emission is measured continuously.	Output	Emission	NOx	0.243			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	
Method: The formed amount for the year.	Output	Residue	Ashes	6.21			g	Technosphere	
Method: The formed amount for the year.	Output	Residue	Ion exchanger	0.00223			g	Technosphere	
Method: The formed amount for the year.	Output	Residue	Waste	0.208			g	Technosphere	
Method: The formed amount for the year.	Output	Residue	Waste oil	0.0223			g	Technosphere	

About Inventory

Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1996. The data consists of average data on a year basis. This data is assumed to be valid until new national or local regulations are enforced in Sweden. This data should only be used on plants producing heat in Sweden and for swedish conditions. When both heat and power are produced the allocation between the products are the same. That is the environmental load for 1 kWh produced heat are the same as for 1 kWh produced electrical power.

About Data	GENERAL DATA SOURCE DESCRIPTION: Data quality in the meaning good precision for the operation of the plant concerning for example the precision of emission measurements, calibration of instruments are good for plants larger than 10 MW and/or plants with a production larger than 25 GWh/year. These plants are included in the NOx control system . At these plants the instruments for NOx-control and calculations are controlled every year at the periodical inspection. Most larger plants are also calibrating other instruments in there own interest or as a consequence of an internal control program.
Notes	

SPINE LCI dataset: Wood pellets fired plant for heat production - Small plant

Administrative	
Finished	Y
Date Completed	1999-08-30
Copyright	
Availability	Public

Technical System	
Name	Wood pellets fired plant for heat production - Small plant
Functional Unit	1 kWh produced and delivered heat.
Functional Unit Explanation	The emissions and use of raw materials are associated with the net production of 1 kWh heat.
Process Type	Gate to gate
Site	Sweden
Sector	Grid electricity and district heat
Owner	Sweden
Technical system description	BRIEF DESCRIPTION: This technical system describes the incineration process in wood pellets fired plant for heat produciton. The plant is located in Sweden. The heat is delivered to a district heating net. Production of materials, chemicals, electricity and transport used in association with the fuel chain and the operation and maintenance of the plant are not included. TECHNICAL DATA FOR THE STUDIED PLANT: The technical data for this system is reported from the periodaical investigation of the plant. Total thermal output (MW): 1,58 Fuel use during the periodical investigation (MWh): 1,48 Production of heat during the periodical investigation (MWh): 1,58 Degree of thermal efficiency (%): 93,8 PROCESS DESCRIPTION: The plant consists of one boiler unit for the insineration of wood pellets. The thermal output is 1,58 MW. The dust is removed from the flue gas in a cyclone. INCLUDED OPERATIONS: The process studied consists of the following operations: - The feeding of the wood pellets into the combustion process. - The combustion process. - The removal of dust from the flue gas in the cyclone. - The internal consumption of electricity. NOx CONTROL: The boiler is not equiped with any NOx control system. OTHER FLUE GAS CLEANING SYSTEMS: - For the removal of dust from the flue gas a cyclone is used. The combustion gases with the particles are entering the cyclone at a high speed. In the cyclone the particles are separated from the gas stream by centrifugal acceleration forces. - Due to the low sulphur content in wood fuels, no reduction of the sulphur content in the

	flue gas is needed.

System Boundaries

Nature Boundary	CRITERIAS USED FOR SELECTING FLOWS: Most data for reported in- and outflows are taken from the final inspection of the plant. The emission of HC is not measured.
Time Boundary	APPLICABLE TIME OF SYSTEM: This inventory was conducted using data mainly from 1996. The data consists of data from the periodical inspection.
Geographical Boundary	GEOGRAPHICAL EXTENSION This inventory has been conducted on a plant fired with wood pellets for heat production in Sweden, with swedish regulations, applicable during 1996. The collected data should be used for swedish conditions.
Other Boundaries	NOTES OF EXCLUDED TECHNICAL SYSTEMS: The following operations have been excluded from the system: - The distribution of district heat from the plant to the consumers. - Building of the plant and the district heating net. - The cradle to gate of the internal electricity consumption. - The production of the wood pellets. - The transportation of the fuel to the plant. - The transportation of the residues from the combustion and cleaning processes to the landfill or back to the forest. - The processes at the landfill such as leaching, decomposition etc. - The spreading of the ashes in the forest. EXCLUDED FLOWS - The water consumption in the process. - The chemicals for feed water treatment.
Allocations	PRINCIPLE APPLIED: In a heating plant one product of economic value is produced, heat. For operation and maintenance of the plant the use of resources and the emissions are associated in relation to the net production of heat. DESCRIPTION:
Systems Expansions	N/A

Flow Data

General Activity QMetaData

Date Conceived	1996
Data Type	
Represents	See 'Function'.
Method	All data reported is related to the functional unit 1 kWh produced and delivered heat. The data is originally given as the average value for one hour of an input (fuel, chemical, electricity etc.) to or an output (emission, product) from the energy plant. The inputs and outputs are then related to the functional unit by dividing the average amount with the amount of produced heat for one hour. For some flows specific information is given, see each flow.
Literature Reference	Data are taken from the final inspection of the plant, 1996, Borås Energi AB.
Notes	The parameters that are presented are chosen because they were presented in the report from the final inspection of the plant. Data can be missing if it is not reported in the report. All values are reported with 3 figures. The data are however seldom that accurate.

Flow Table and Specific Meta Data

QMetaData	*Direction*	*FlowType*	*Substance*	*Quantity*	*Min*	*Max*	*Unit*	*Environment*	*Geography*
Method: The consumed amount for the year.	Input	Refined resource	Bio fuel	225			g	Technosphere	
Method: Not known.	Input	Refined resource	Electricity	0.06			kWh	Technosphere	
Data type: Single sample Method: This emission was measured at the final inspection of the plant. The yearly amount was then estimated from this single sample.	Output	Emission	CO	0.288			g	Air	
Method: The yearly amount of this emission was estimated by using the standard value for CO2-emissions from plants fired with biofuels, according to NUTEK. The standard value for biofuels is	Output	Emission	CO2	438			g	Technosphere	

114 g/MJ fuel supplied									
Data type: Single sample Method: This emission was measured at the final inspection of the plant. The yearly amount was then estimated from this single sample.	Output	Emission	Dust	0.149			g	Air	
Data type: Single sample Method: This emission was measured at the final inspection of the plant. The yearly amount was then estimated from this single sample.	Output	Emission	NOx	0.376			g	Air	
Data type: Single sample Method: This emission was measured at the final inspection of the plant. The yearly amount was then estimated from this single sample.	Output	Emission	SO2	0.04			g	Air	
Method: Not known.	Output	Product	Heat	1			kWh	Technosphere	
Method: The formed ampount for the year.	Output	Residue	Ashes	5.78			g	Technosphere	

About Inventory	
Publication	LCA värme, Vattenfalls Livscykelanalyser, Produktion av värme; Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius; SwedPower AB, Miljö & Kvalitet; 1999-07-01. -- Data documented by: Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders at SwedPower AB Documentation reviewed by: Ann-Christin Pålsson, CPM, Chalmers University of Technology --
Intended User	Intended user of the data are
General Purpose	The general purpose of the inventory was to obtain a lifecycle inventory of heat producing plants using different types of fuels. A further purpose was to obtain data from heat producing plants with different capacities.
Detailed Purpose	The specific purpose is to compare data from plants producing heat, with various fuels, combustion technologies and flue gas cleaning systems.
Commissioner	Bodlund, Birgit - Vattenfall AB.
Practitioner	- SwedPower AB, Maria Münter, Emanuel Nandorf, Pernilla Strömberg, Andrea Wallenius, Birgitta Olanders .
Reviewer	Pålsson, Ann-Christin - CPM Technical Environmental Planning Chalmers University of Technology 412 96 Göteborg
Applicability	CERTAIN CAUTIONS: This inventory was conducted using data mainly from 1996. The data consists of average data from a few hours during the periodical inspection. The data should only be used on plants producing heat in Sweden and for swedish conditions.
About Data	GENERAL DATA SOURCE DESCRIPTION: The emissions from plants with a thermal output of <10 MW are often based on few measurements for example the final inspection of the plant or the periodical inspection.
Notes	

SPINE LCI dataset: Wool/polyamide covering of sofa. ESA-DBP

Administrative	
Finished	Y
Date Completed	2004
Copyright	Environmental Systems Analysis, Chalmers Univ. of Technology
Availability	Public

Technical System

Name	Wool/polyamide covering of sofa. ESA-DBP
Functional Unit	''The functional unit was: surface covering of a 3-seat sofa for private use during 10 years.'' For wool/PA fabric it is 5.27 kg per sofa.
Functional Unit Explanation	See 'Function'.
Process Type	Cradle to grave
Site	Not applicable
Sector	Consumer goods
Owner	Not applicable
Technical system description	The system is descibed in ''Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector - a case study concerning fabrics for a sofa. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden'': http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2004--7.pdf Other processes in the CPM Database also included in the above publication: 'Cotton (conventional) fibres production. ESA-DBP', 'Cotton covering of sofa. ESA-DBP' and 'Flame retardant polyester (Trevira CS) covering of sofa. ESA-DBP'. ''The function was to provide a surface covering for a sofa. The fiber type in this LCA was conventional cotton. The color of the fabric was red. Six dry cleaning sessions for the Woll/PA fabric was assumed in order to see the relative environmental importance of the cleaning step. It was assumed that the fabric could be readily removed from the sofa. Incineration at disposal of the fabric used was assumed in the base case (the most probable life cycle chains). Heat recovery and emissions from the incineration were taken into account, but possible oil saving or replacement of other waste in the incinerator was only tested in the sensitivity analysis.'' ''Fabric for sofas with wool are usually mixed with a synthetic material, often with polyamide (PA, nylon). The weaving mills investigated used PA 66 in different amounts, from 9% to 15%. Here it was assumed that 15% of the fabric is PA 66. The wool is usually spun with a worsted system, and wool from New Zealand is popular for this application. The fiber diameter varies between 25 and 32 micrometer according to 2 of the weaving mills. In figure 4, in the ESA report 2004-7, the different companies and their roles in the production of wool/PA fiber are shown. ''The raw wool contains wool, grease, suint (sweat residues), dirt, vegetable matter and agrochemicals. In the wool scouring and combing process, the raw wool is cleaned and combed in order to get wool tops for the spinning of yarn (Ellebäk Laursen et al, 1997). The most common type of scouring takes place in water.'' In the litterature reference following processes are included: - Sheep farming in New Zealand - Shearing, removal of oddments - Truck from shearing to classing and selling of wool - Classing, baling and selling of raw wool - Freighter from New Zealand to Bremen (Germany) - Wool scouring, combing, shrink proofing, effluent treatment at Bremer Woll-Kämmerei AG (BWK) - Truck from scouring plant to spinning plant - Production of polyamide 66 (nylon) - Truck from polyamide plant to spinning mill - Spinning of wool yarn - Truck and boat from spinning mill to Swedish weaving mill - Weaving without sizing in Sweden - Business trips from wool/PA weaving mills site - Truck from weaving mill to wet treatment plant - Dyeing of wool fabric including pretreatment, rinsing and drying - Truck from Swedish wet treatment plant back to weaving mill - Textile distribution at weaving mill site in Sweden - Truck from Swedish weaving mill to upholstery plant - Upholstering of wool/PA fabric on a 3-seat sofa - Dry-cleaning - Truck from user to incineration plant - Incineration of wool/PA fabric

System Boundaries

Nature Boundary	''Mineral resources and water were traced back to their reserves in nature and emissions were followed to air, water or soil. Below are the exceptions found, when the processes were not traced back to the nature reserves or water, or followed to air, water or ground. - A wastewater-treatment plant was included, but the decomposition of each individual chemical was not studied. - The production of the process chemicals and some packaging materials were not within

	the system boundaries.''
Time Boundary	''Data were collected by interviews from 1999 to 2002, but data from reports ranged from 1993 to 1998. Most reports were from 1997.''
Geographical Boundary	''Wool/PA: *production of raw wool: New Zealand *wool scouring, spinning of wool yarn: Germany *PA production: Europe *weaving, wet treatment including dyeing of the fabric, upholstering, use and incineration: Sweden''
Other Boundaries	''The fabrics were assumed to not to be worn out before they were disposed of, a realistic scenario for Swedish conditions. Therefore the abrasion resistance was not taken into consideration in the study, while the effect of different lifetimes of the fabrics is discussed in chapter 4.3.7.'' ''Truck from shearing to classing and selling of wool The distance was assumed to 300 km.'' ''Classing, baling and selling of raw wool Energy use was not known for classing, baling and selling of raw wool. It was considered insignificant and was assumed to zero.'' ''Freighter from New Zealand to Bremen (Germany) The distance was estimated to be 24,753 km. The assumption was made that the freighter goes north of Australia and through the Suez Canal. The data represents transportation by a large freighter.'' ''Wool scouring, combing, shrink proofing, effluent treatment at Bremer Woll-Kämmerei AG (BWK) - Grease was assumed to replace mineral oil, here approximated to be heavy fuel oil. - Input of energy: Calculations were made on the basis of energy demand for the plant and recognizing that 90% of the energy is for wool. Data are for total energy use including everything in the plant. The total energy use is 23 MJ/kg raw wool. DWI (1997) states that totally 31.30MJ/kg raw wool is used for wool scouring and combing (scouring only: 5.79 MJ). The data above indicate less energy use than in the DWI statement, but energy from incineration of material in the effluent is used at BWK, which could explain the difference. - At BWK, ammonia and soda are recovered. About 50% of the wool wax (grease) is deodorized and sold. Energy from incineration of material in the effluent is used. 90% of the electricity and all heat (steam) are generated in their own plant using coal. - Inputs of chemicals: It was assumed that only wool needs these chemicals. (80% of the fibers treated are wool, the only fiber that needs scouring at BWK). The rest need only combing. Water consumption reported in the BWK brochure is assumed to be only for wool scouring. - Waste: BWK reported total amounts. The following assumptions were made: from wool only (the rest comes from all fibers proportionally): sludge, sand, wool dust, raw wool packaging, fabric. If more than 50% of the waste is recycled it is reported as Non-Elementary to the Technosphere in LCAiT. If more than 49% of the waste is not recycled it is reported as Elementary waste to ground.'' ''Truck from scouring plant to spinning plant The distance from Bremen to the spinning mill was assumed to 60 km.'' ''Truck from polyamid plant to spinning mill The distance was assumed to 100 km.'' ''Spinning of wool yarn Paraffins are only sometimes used. Here they were assumed as not used.'' ''Truck and boat from spinning mill to Swedish weaving mill The distance with a large freighter was assumed to 40 km. The distance by truck was assumed to 857 km.'' ''Business trips from wool/PA weaving mills site The travel distance was calculated to 0.63 vkm/kg fabric.'' ''Truck from weaving mill to wet treatment plant The distance was assumed to 30 km.'' ''Dyeing of wool fabric including pretreatment, rinsing and drying - The drying step also includes fixation. No carbonizing is done. - It is approximated that the colorants fixate to 75% on the fiber. This assumption only affected the weight of the fabric here, since the fate of the chemicals was not followed.'' ''Truck from Swedish wet treatment plant back to weaving mill The distance was assumed to 30 km.'' ''Truck from Swedish weaving mill to upholstery plant The distance was assumed to 500 km.'' ''Truck from user to incineration plant The distance to the incineration plant was assumed to 25 km.''

Allocations	''The allocation procedure by mass was not uniform in applications. The deviations were as follows: - No flows were allocated to waste, such as edge strips from weaving or cardboard or textile samples. - Wool was allocated 40% to wool and 60% to meat (economic allocation). - In the weaving operation, allocation was made per meter fabric. - Allocations for light fuel oil, heavy fuel oil, LPG and natural gas production were not known as well as for electricity from natural gas or oil and production of sodium hydroxide and ethylene glycol used for the sensitivity analysis. - For electricity production (Swedish average) the allocation between recycling and virgin materials was according to the 50/50 method. When heat was also produced, the allocation was according to energy output. - For electricity (European average), exergy values were used to allocate between electricity and heat.'' ''Sheep farming in New Zealand In Ellebäk Laursen et al (1997) 40% of the environmental impact from sheep was allocated to wool and this allocation was also made in this ESA-report. This estimate is based on a global estimation that in most countries sheep are held for meat production with the important exception Australia where sheep are held mainly for wool. Sheep give about 4.5-5 kg fleece/year (Ellebäk Laursen et al (1997)). It is fairly clear that Ellebäk Laursen et al mean raw wool with oddments when giving data for ''raw wool'' . On the assumption that Ellebäk Laursen et al mean wool including oddments, oddments were assumed to have the same environmental impact per kg as first quality raw wool, and also in this case study this is assumed since it can be assumed that wool with oddments can replace first quality wool in some applications.''
Systems Expansions	''In the life cycle of the wool/PA fabric 1.03 kg grease and 2.87 kg wool oddments (stained wool) are also generated, but are not outputs here because their benefits are calculated (system expansion).''

Flow Data

General Activity QMetaData

Date Conceived	Unknown
Data Type	Calculated
Represents	See 'Function'.
Method	The data is produced with the software tool LCAit.
Literature Reference	Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector - a case study concerning fabrics for a sofa. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden http://www.cpm.chalmers.se/CPMDatabase/DataReferences/ESA_2004-7.pdf
Notes	''In the life cycle of the wool/PA fabric 1.03 kg grease and 2.87 kg wool oddments (stained wool) are also generated, but are not outputs here because their benefits are calculated (system expansion).'' This data set is generated with the software LCAit. All values that are below 0.001 kg and values given in the unit Bq are excluded. These values can be found in the litterature reference.

Flow Table and Specific Meta Data

QMetaData	***Direction***	***FlowType***	***Substance***	***Quantity***	***Min***	***Max***	***Unit***	***Environment***	***Geography***
	Input	Refined resource	Acetic acid	0.184			kg	Technosphere	
	Input	Refined resource	Acids	0.118			kg	Technosphere	
	Input	Refined resource	Antistatic agent	0.012			kg	Technosphere	
	Input	Refined resource	Antraquinone colorant	0.00558			kg	Technosphere	
	Input	Refined resource	Avivages/Softening agents	0.0301			kg	Technosphere	
	Input	Refined resource	Azocolorant anionic	0.114			kg	Technosphere	
	Input	Refined resource	Calcium carbonate	0.116			kg	Technosphere	
	Input	Refined resource	Cardboard	0.233			kg	Technosphere	
Notes: Other Chemicals	Input	Refined resource	Chemicals	0.778			kg	Technosphere	
	Input	Refined resource	Emulsifying agent	0.0659			kg	Technosphere	
	Input	Refined resource	Fatamine polyclycolether	0.119			kg	Technosphere	
	Input	Refined resource	FeSO4	0.0413			kg	Technosphere	

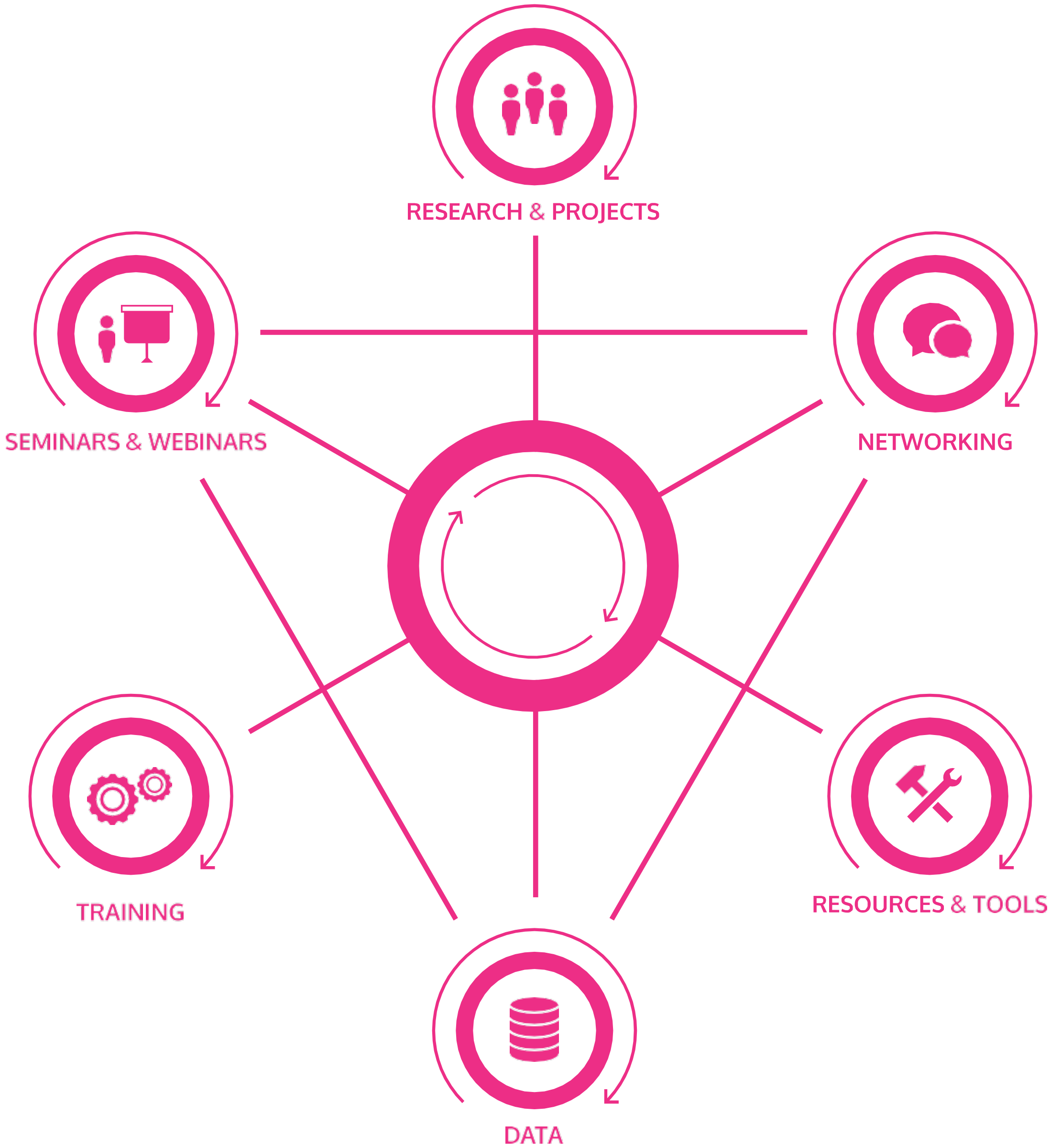
Notes: In solution.	Input	Refined resource	Iron chloride sulphate	0.0594			kg	Technosphere	
	Input	Refined resource	Lime	0.00156			kg	Technosphere	
	Input	Refined resource	Lubricant oil	0.00000531			m3	Technosphere	
	Input	Refined resource	Na2SO4	0.556			kg	Technosphere	
	Input	Refined resource	Other fuel	11.2			MJ	Technosphere	
Notes: Packaging materials	Input	Refined resource	Packaging	0.0992			kg	Technosphere	
	Input	Refined resource	Paper	0.0255			kg	Technosphere	
	Input	Refined resource	Perchlorethylene	0.0395			kg	Technosphere	
	Input	Refined resource	PO43-	0.58			kg	Technosphere	
	Input	Refined resource	Sodium acetate	0.0918			kg	Technosphere	
	Input	Refined resource	Sodium hydroxide	0.164			kg	Technosphere	
	Input	Refined resource	Sulphuric acid	0.00261			kg	Technosphere	
Notes: Other supply materials	Input	Refined resource	Supply materials	0.307			kg	Technosphere	
	Input	Refined resource	Surfactants	0.0931			kg	Technosphere	
	Input	Resource	Agricultural land	723			m2 year	Ground	
	Input	Resource	Bauxite	0.0192			kg	Ground	
	Input	Resource	Biomass	0.293			kg	Ground	
	Input	Resource	Crude oil	6.5			kg	Ground	
	Input	Resource	Hard coal	15.6			kg	Ground	
	Input	Resource	Hydro energy	79.8			MJ	Ground	
	Input	Resource	Iron in ore	0.00224			kg	Ground	
	Input	Resource	Lignite	6.18			kg	Ground	
	Input	Resource	Limestone	0.313			kg	Ground	
	Input	Resource	Natural gas	3.11			kg	Ground	
	Input	Resource	Potassium chloride	0.00207			kg	Ground	
	Input	Resource	Sodium chloride	0.0842			kg	Ground	
	Input	Resource	Softwood	0.00369			kg	Ground	
	Input	Resource	Sulphur in ore	0.0265			kg	Ground	
	Input	Resource	Unspecified fuel	0.0000887			MJ	Ground	
Notes: Unspecified type of water.	Input	Resource	Water	2870			kg	Water	
	Input	Resource	Wind energy	0.121			MJ	Ground	
	Input	Resource	Wood	0.991			kg	Ground	
	Output	Emission	BOD	0.0236			kg	Water	
	Output	Emission	Cl-	0.192			kg	Water	
	Output	Emission	CO	0.0909			kg	Air	
Notes: Renewable.	Output	Emission	CO2	5.75			kg	Air	
	Output	Emission	CO2	67.7			kg	Air	
	Output	Emission	COD	0.0357			kg	Water	
Notes: Discharges to soil via sludge.	Output	Emission	Dyeing agents	0.0299			kg	Ground	
	Output	Emission	Fe	0.00918			kg	Water	
	Output	Emission	HCl	0.00263			kg	Air	
	Output	Emission	Methane	6.23			kg	Air	
	Output	Emission	N total	0.00538			kg	Water	
	Output	Emission	N2O	0.00988			kg	Air	
	Output	Emission	NH3	0.947			kg	Air	
	Output	Emission	NH4+	0.00237			kg	Water	
	Output	Emission	NMVOC	0.0496			kg	Air	
	Output	Emission	NMVOC, diesel engine	0.0102			kg	Air	
	Output	Emission	NMVOC, oil combustion	0.00179			kg	Air	
	Output	Emission	NO3-	0.0276			kg	Water	

	Output	Emission	NOx	0.28			kg	Air	
	Output	Emission	Oil	0.0038			kg	Water	
	Output	Emission	Other organics	0.00314			kg	Water	
	Output	Emission	Particles	0.0395			kg	Air	
	Output	Emission	Pesticides	0.0000112			m3	Ground	
	Output	Emission	SO42-	0.0709			kg	Water	
	Output	Emission	Sodium chloride	0.0205			kg	Water	
	Output	Emission	SOx	0.345			kg	Air	
	Output	Emission	Suspended solids	0.00186			kg	Water	
	Output	Residue	Bulky	2.32			kg	Technosphere	
	Output	Residue	Cardboard	0.205			kg	Technosphere	
	Output	Residue	Construction waste	0.0482			kg	Technosphere	
	Output	Residue	Demolition	0.00109			kg	Technosphere	
	Output	Residue	Edge strips	0.145			kg	Technosphere	
	Output	Residue	Fabrics	0.278			kg	Technosphere	
Notes: Hazardous output	Output	Residue	Hazardous waste	0.0319			kg	Technosphere	
	Output	Residue	Heat	-108			MJ	Technosphere	
Notes: Domestic waste	Output	Residue	Household waste	0.0258			kg	Technosphere	
	Output	Residue	Lubricant oil	0.00000531			kg	Technosphere	
Notes: unspecified metals	Output	Residue	Metals	0.0301			kg	Technosphere	
	Output	Residue	Mineral waste	0.00753			kg	Technosphere	
	Output	Residue	Minerals	0.296			kg	Technosphere	
Notes: Industrial waste	Output	Residue	Mixed industrial waste	0.0159			kg	Technosphere	
Notes: Industrial output	Output	Residue	Mixed industrial waste	3.65			kg	Technosphere	
	Output	Residue	Non-toxic chemicals	0.00415			kg	Technosphere	
	Output	Residue	Other	1.72			kg	Technosphere	
	Output	Residue	Packaging	0.192			kg	Technosphere	
	Output	Residue	Paper	0.00861			kg	Technosphere	
	Output	Residue	Perchloroethylene	0.0395			kg	Technosphere	
	Output	Residue	Polyethylene	0.0134			kg	Technosphere	
	Output	Residue	Polypropylene	0.415			kg	Technosphere	
	Output	Residue	Radioactive	0.00158			kg	Technosphere	
	Output	Residue	Regulated chemicals	0.00513			kg	Technosphere	
	Output	Residue	Sand	0.663			kg	Technosphere	
Notes: Filter dust and boiler slag	Output	Residue	Slag	0.169			kg	Technosphere	
Notes: Ashes	Output	Residue	Slag/Ashes	0.00268			kg	Technosphere	
Notes: Fly ash and slag	Output	Residue	Slag/Ashes	0.391			kg	Technosphere	
	Output	Residue	Slags and ash	0.0125			kg	Technosphere	
Notes: energy production	Output	Residue	Slags and ash	0.608			kg	Technosphere	
Notes: Elementary waste via non-elementary outputs.	Output	Residue	Sludge	1.13			kg	Technosphere	
	Output	Residue	Spillage	0.607			kg	Technosphere	
Notes: With packaging.	Output	Residue	Textile sample	0.332			kg	Technosphere	
	Output	Residue	To incinerator	0.00187			kg	Technosphere	
	Output	Residue	Wood	0.734			kg	Technosphere	

About Inventory

Publication	Dahllöf L, 2004, Methodological issues in the LCA procedure for the textile sector - a case study concerning fabrics for a sofa. Environmental Systems Analysis report 2004:7, Chalmers University of Technology, Gothenburg, Sweden http://cpmdatabase.cpm.chalmers.se/DataReferences/ESA_2004-7.pdf
Intended User	LCA and textile practitioner
General Purpose	Part of doctoral studies. ''The overall purpose of the studies is to give suggestions for solving some of the methodological issues within the LCA method when used in the field of textiles.''
Detailed Purpose	''The goal of this case study was to identify, map and discuss LCA methodological issues in the textile sector. This was done by carrying out an LCA study with the goal of ranking three fabric types for a sofa. i) The main reason for carrying out the study was that the LCA methodology is not fully developed and different sectors have different method development needs. This work was being done on the basis of interest from the textile industry in Sweden. ii) The study could be used for further development regarding methodological issues in the efforts

	to establish Product Specific Rules (PSRs) for Certified Environmental Declarations (EPDs) in the textile sector (the Swedish Environmental Management Council 2000) and for the modification work of the ISO 14040 (1997) - ISO 14043 (2000) standards. iii) It is intended to be used by purchasers, designers, etc., in the textile industry as well as for researchers and others working with the ISO 14040 (1997) - ISO 14043 (2000) standards.''
Commissioner	Stiftelsen Svensk Textilforskning - .
Practitioner	Lisbeth Dahllöf - .
Reviewer	Maria Walenius Henriksson - IFP Research AB
Applicability	For applicability for the process see 'Technical System' and 'System Boundaries' above.
About Data	'' Wool scouring, combing, shrink proofing, effluent treatment at Bremer Woll-Kämmerei AG (BWK) Air emissions come from evaporation, incineration and the coal-fired plant. Data reported are from the total amount. It is calculated on the basis of energy demand and that wool is responsible for 90% of these emissions.'' ''Production of polyamide 66 (nylon). Data source: average production data in Europe. The data are a weighted average based on production volume from 7 different plants in Germany, Austria and the Netherlands (about 30% of total European production). The amount of packaging was estimated in this LCA study.'' ''Spinning of wool yarn Data came from one spinning mill. Worsted spinning system data for the dimension of Nm 36/2 was reported, since this is what the representatives from the weaving mills state they often use for upholstery qualities. The representative from the spinning mill also claimed that this is the standard type of yarn for upholstery fabrics. The activities included are: preparation, ring spinning, rinsing, and twisting of worsted Nm 36/2 yarn. Energy consumption for light and air conditioning was included. Water consumption was not reported, and is therefore not included here. The data for packaging material come from one weaving mill. All energy was assumed to be electricity.'' ''Dyeing of wool fabric including pretreatment, rinsing and drying - Data for energy (not specified) and BOD, came from Ellebäk Laursen et al (1997). The range for energy use is reported there to 3.40-13.2 MJ/kg textile (Dyeing/washing/drying) and 4.05-8.00 MJ/kg textiles for finishing. - BOD for scouring: 47 g/kg textile, dyeing is reported to 9-34 g/kg textile and finishing 2-80 g/kg textile according to Ellebäk Laursen et al (1997). There was no finishing of the fabric. - The formulation for dyeing is an average of data from one wet treatment mill and a standard formulation from Clariant Sweden (2001). Data were for a dark red color. - The dyer used a machine for dyeing called THEN Soft Stream, a kind of HT machine. - Owing to poor data, general water and energy use were not included. - Data for water consumption are a combination of the wet treatment mill, data for cotton fabrics rinsing and data from Ellebäk Laursen et al (1997). - It is approximated that the colorants fixate to 75% on the fiber. This assumption only affected the weight of the fabric here, since the fate of the chemicals was not followed. - Data for non-elementary discharges to water of metals were not known. - The packaging is cardboard rolls. PE that is wrapped over was assumed to insignificant. - Surfactant for the washing was not included, owing to absence of data.'' ''Dry-cleaning - Data from Österlund B (2002). The chemicals reported end up in a destruction plant (e.g. incineration). Much more solvent is used, but it is distilled and reused, therefore it is not added as a new chemical for each dry-cleaning. Distillation energy and general energy were included.'' ____ ESA Database Project. Years: 2009-2011. Administering organisation: Chalmers University of Technology, the department of Environmental Systems Analysis. Financier: The Swedish Research Council. Importer of data: Filippa Fuhrman (ESA), assisted by Johan Tivander (ESA). Review committee for imported data: Johan Tivander (ESA), Emma Rex (CPM, Center for environmental assessment of Product and Material systems), Bengt Steen (ESA), Anne-Marie Tillman (ESA).
Notes	The original publication includes more information about data. ''The studies are being carried out at the Environmental Systems Analysis Department at Chalmers University of Technology in Gothenburg, Sweden and are being financed mainly by Stiftelsen Svensk Textilforskning and CPM, Centre for Environmental Assessment of Product and Material Systems.''



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