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An estimation of loss of natural capital from emissions and use of natural resources 2025

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Abstract

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The EPS system is an LCA method including a database of monetary values for environmental impacts from elementary flows. Such values change with inflation, salaries, costs and new knowledge on impact pathways. User needs also change and put new requirements on communication and dissemination of results. The purpose of this report is to update these monetary values to reflect the state of art in 2025.

We use web searches to review and update data given in earlier EPS versions, sometimes AI assisted. Results from AI are never used as a final result, but often as a search engine.

We have determined 107 new monetary values for environmental goods and 1074 new values for loss of natural capital from elementary flows. Uncertainty factors have been updated and adapted to LCA conditions. For product systems emissions normally exist at several different locations, resulting in lower uncertainty factors compared to those from single locations.

The global loss of natural capital is highest for CO2 emissions. The rank remains as nr 1 from the 2020 version to this version. The second highest loss of natural capital is for gold extraction, and the third for oil extraction.

Updated monetary values for environmental goods and elementary flows have changed compared to the 2020 version due to changes in prices and cost and due to new knowledge on impact pathways. Uncertainty estimates have also changed due to new knowledge on impact pathways.

Future updates are recommended. The Excel file in the supplementary material will help with such updates.

Introduction

Natural capital is defined by ISO as “stock of renewable and non-renewable natural resources (e.g. plants, animals, air, water, soils, minerals) of a given quality” (ISO 2025). The term “natural capital” has been used in literature for many years (Schumacher 1973; Costanza and Daly 1992). Natural capital accounting for nations is internationally harmonized as SEEA, System of Environmental-Economic Accounting (UN 2014). SEEA is a satellite system to SNA, System for National Accounts, and aims at satisfying the needs of nations to safeguard their natural capital in its capability to support human welfare. Natural capital accounting for organizations is internationally harmonized by ISO (ISO 2025). Natural capital accounting may also be made for products and product systems. EU has published a directive, “Empowering consumers” (EmpCo) where monetary values for environmental impacts has a role to play. Monetary values of impacts on natural capital may be used for weighting in LCA (ISO 2017), suitable for empowering consumers to choose the most sustainable among product alternatives.

However, accounting needs data; data on flows, data on flow units’ impact, and data on values of changes in natural capital. The standards mentioned above are procedural standards and contain very little data. The world changes fast. New knowledge on impacts, changes of monetary values due to economic growth and inflation, and new user demands make old data obsolete and call for updates.

This report aims at updating monetary values for global impacts on natural capital from emissions and use of resources to the year 2025.

As of 2025, in comparison to 2020 for which the preceding EPS version were made, new knowledge is available on some material impacts, such as on climate, on decrease of natural resources, and on human health from particles.

Economy is the art and science of managing scare resources. It has system boundaries in terms of 1) whose economy that is assessed, 2) for which time, 3) what is included to be valued, and 4) what kind of values that are used.

There are many economies. Different economies interact. This update represents a global, intergenerational economy for the natural capital. Neoclassical economy has a short time perspective and focuses on prices and consumer behavior. It assumes that consumers are well informed when they make their choices. The aim of this update is to maintain and strengthen consumer understanding of environmental external costs, and impacts on the natural capital.

Method

The EPS system approach has been used to determine monetary values for environmental impacts of emissions and use of resources.

The first version of the EPS system was developed in the late 1980-ies as a request from product developers at Volvo in Gothenburg. In the development of a new car model there are several thousand decisions to be made, and several performance criteria to be fulfilled. In the late 1980-ies, increasing attention was paid to environmental issues in product design, and a new performance indicator was needed. It was requested that only one indicator, covering all environmental impacts, be available and be available within five minutes. Otherwise, it was unlikely that the indicator would have an influence on the design of the product. The approach to determine the indicator was named the “Environmental Priority Strategies in product design”, or short “the EPS system”. It contained both a framework, methods to determine the indicator, and a database. The first versions focused on the including of all relevant aspects and meeting the requirement on quick answers. An LCA approach was chosen and in the early 90ies monetary valuation was adopted as a weighting principle. The first version was published in 1992 (Steen and Ryding 1992). It was refined in the 1996, 2000, 2015, and 2020 versions. (Steen 1999; Steen 2016, 2019)

The development of the EPS methodology has always followed a top-down and hermeneutic approach. Any change is motivated by its potential for improving the environmental performance in a product development context. Default versions are published and high transparency is aimed for to support adaptation to new conditions, be it local, user specific, or new default versions. Each version is evaluated through sensitivity analyses in case studies to find where the need for improvement is highest.

This update is made relative to the 2015 and 2020 environmental impact assessment versions (Steen 2016; Steen and Rydberg 2020; Steen 2019). The update includes

1. Choice of pathways to model

2. Monetary valuation of environmental goods (“endpoints” in LCA)
3. Characterization factors
4. Uncertainty assessment
5. Quality check

Choice of pathways to model

The principle used for choosing to quantitatively model a pathway is that there should at least be one scientific refereed publication of the causality considered, and on the data needed for determining characterization factors. New literature on pathways is searched for on Scopus and Firefox, the latter AI assisted.

Monetary valuation of environmental goods

The update includes market values for traded goods, earnings, prevention and replacement costs, and DALY factors for diseases. The same method is used as in earlier versions with web-searching of scientific literature and renown databases like FAO, USGS, World Bank, OECD.

Characterization factors

A characterization factor for a pathway is determined as the product of 1) the extent of an impact caused by a particular mechanism, e.g. years of lost life expectancy from heat stroke and 2) the contribution to that impact from one unit of elementary flow, e.g. 1 kg of CO2. New literature, e.g. the IPCC AR6 report is used for updates. New literature on pathways is searched for on Scopus and Firefox, the latter AI assisted.

Uncertainty assessment

This update is more complete in its uncertainty assessments than earlier versions. All best estimates have an uncertainty estimate, and all uncertainty estimates are explained and motivated. The uncertainty is primarily intended to be used in Monte Carlo simulations to determine the probability that one product alternative is better than an other, and for sensitivity analysis. There are different types of uncertainties such as 1) measurement uncertainties for input data 2) model uncertainties and 3) epistemological uncertainty i.e. using data from one context in another context. Some of the epistemological uncertainty has to do with unclear definitions, like “meat” covering all sorts of meat. Some have to do with true variations like acidification impacts, which vary with time and space in different regions. As product systems include elementary flows from several unit processes and thus several points of emissions and resource extractions, the resulting variance of product systems’ environmental impacts, is lower than that for a single unit process. As default we assume 10 emissions point resulting in a reduction of the standard deviation with a factor of $\sqrt{10}$ = 3.16 for product systems. A log-normal distribution is assumed as default, and median values are used for best estimates if such are available. In some cases, linear normal distributions and averages are used, but then it is noted. Uncertainties are given as standard deviations, which in case of log-normal distributions are expressed as factors. For example, a factor of 1.2 means that a value X lies between X/1.2 and X*1.2 with 68% probability. It also means that X lies between X/1.2^2 and X*1.2^2 with 95% probability. If, for instance, the standard deviation for the impact measure of individual emission points is 1.8, the standard deviation factor for the average of ten emission points is EXP(LN(1.8)/3.6) = 1.18. The updated uncertainty factors for environmental goods are shown in table 1. Uncertainty factors for elementary flows are not given as generic numbers as they are not independent of each other, and thus not suitable for use in Monte Carlo simulations. Instead, they are given for data used in the impact models. Such uncertainty factors and explanations and references to uncertainty factors are given in the supplementary material (Steen 2026).

Quality check

The primary tool for quality checks is uncertainty assessment. Direct questions, mostly on Firefox, is used to find out if there is a similar estimation made by AI. If not, an explanation is looked for, but AI answers are never used as final results. Updating is, in itself, a quality check.

Results

Adaption to common frameworks

Recent years there has been some new applications for EPS data, such as to evaluate company performance and to empower consumers. Evaluating company performance may either be for internal use in companies, e.g. for reporting, or for external use by e.g. the finance sector. The EU EmpCo directive supports the basic structure of the EPS system in delivering measures that can be understood by laymen (monetary values of impacts) and transparency with respect to how these were calculated.

This does not change much of the basic modelling and calculations made in the EPS impact assessments update, but it adds new requirements on how values are reported and disseminated. A new use of the monetary values for emissions and resources is in the business and finance sector, where there is a need for “value factors”, i.e. economic impacts of emissions and use of natural resources.

In earlier EPS versions the weighted impacts were expressed in ELU/flow unit, where 1 ELU was equal to 1 €. This was done to distinguish between impact values and commercial values. Now, environmental economy is more accepted in society, why it is expressed directly in monetary units, in this report €.

Data

Tables with updated impact values are given below for environmental goods, emissions to air, emissions to water, emissions to land and land use. Supporting information is given by Steen (Steen 2025). Climate effects are modeled with anthropogenic impacts and anthropogenic contributions, while exposure/health effects and contributions are anthropocentric + natural. Uncertainty data are for product systems, i.e. uncertainty due to spatial and temporal variations are moderated as product systems typically have several emission points and long-lasting impacts.

Environmental goods

The new values for impacts on environmental goods are given in table 1. Human health is not seen as an environmental good, but as a category of impact indicators. As in preceding versions, values of changes in human health indicators are for person-years of different sequalae. Explanations and references to data presented in table 1 are given in the supplementary material. (Steen 2025)

Table 1 Monetary values of impacts on Environmental goods and services

Environmental good or service	**Impact valued and indicator**	**Indicator unit**	**Loss of natural capital, best estimate (€$_{2025}$/indicator unit)**	**Loss of natural capital, uncertainty**
Production capacity of crop	Decreased production capacity	kg	0.428	1.2
Production capacity of wood	Decreased production capacity	kg	0.23	1.4
Production capacity of meat	Decreased production capacity	kg	2.4225	1.4
Production capacity of fish	Decreased production capacity	kg	3.02	1.5
Production capacity of drinking water	Decreased production capacity	kg	0.000648	3
Biodiversity, global	Redlisted species, number of	total number	8.65E+10	3
Fossil oil resources	Depletion of reserves, mass	kg	1.670	2
Fossil coal resources	Depletion of reserves, mass	kg	0.366	2
Lignite resources	Depletion of reserves, mass	kg	0.110	2
Natural gas resources	Depletion of reserves, mass	m3	0.495	2
Silver(Ag) ore	Depletion of reserves, mass	kg of element	7.37E+04	2
Aluminium(Al) ore	Depletion of reserves, mass	kg of element	1.90E-01	1.3
Argon(Ar) gas	Depletion of reserves, mass	kg of element	0.00E+00	1
Arsenic(As) ore	Depletion of reserves, mass	kg of element	8.14E+02	2
Gold(Au) ore	Depletion of reserves, mass	kg of element	2.60E+06	2
Boron(B) resources	Depletion of reserves, mass	kg of element	1.06E+01	2
Barium(Ba) ore	Depletion of reserves, mass	kg of element	3.55E+01	3
Beryllium(Be) ore	Depletion of reserves, mass	kg of element	2.98E+03	4
Wismuth(Bi) ore	Depletion of reserves, mass	kg of element	2.44E+04	2
Bromine(Br) resources	Depletion of reserves, mass	kg of element	0.00E+00	1
Cadmium(Cd) ore	Depletion of reserves, mass	kg of element	9.92E+04	2
Calcium(Ca) ore	Depletion of reserves, mass	kg of element	0.00E+00	1
Cerium(Ce) ore	Depletion of reserves, mass	kg of element	6.20E+01	2
Chloride(Cl) salt	Depletion of reserves, mass	kg of element	0.00E+00	1
Cobolt(Co) ore	Depletion of reserves, mass	kg of element	2.87E+02	2
Chromium(Cr) ore	Depletion of reserves, mass	kg of element	5.66E+01	2
Cesium(Cs) ore	Depletion of reserves, mass	kg of element	0.00E+00	3
Copper(Cu) ore	Depletion of reserves, mass	kg of element	1.40E+02	2
Dysprosium(Dy) ore	Depletion of reserves, mass	kg of element	1.12E+03	2
Erbium(Er) ore	Depletion of reserves, mass	kg of element	1.70E+03	2
Europium(Eu) ore	Depletion of reserves, mass	kg of element	3.91E+03	2
Fluorine(F) ore	Depletion of reserves, mass	kg of element	7.01E+00	3
Iron(Fe) ore	Depletion of reserves, mass	kg of element	1.19E+00	1.6
Gallium(Ga) ore	Depletion of reserves, mass	kg of element	1.90E-01	2
Gadolinium(Gd) ore	Depletion of reserves, mass	kg of element	9.77E+02	2
Germanium(Ge) ore	Depletion of reserves, mass	kg of element	1.00E+05	4
Hydrogen(H) resources	Depletion of reserves, mass	kg of element	0.00E+00	1
Hafnium(Hf) ore	Depletion of reserves, mass	kg of element	7.37E+02	2
Helium(He) gas	Depletion of reserves, mass	kg of element	0.00E+00	1
Mercury(Hg) ore	Depletion of reserves, mass	kg of element	7.81E+04	2
Holmium(Ho) ore	Depletion of reserves, mass	kg of element	4.71E+03	2
Iodine(I) resources	Depletion of reserves, mass	kg of element	31.8	3
Indium(In) ore	Depletion of reserves, mass	kg of element	6.98E+04	2
Iridium(Ir) ore	Depletion of reserves, mass	kg of element	1.78E+08	3
Potassium(K) salt	Depletion of reserves, mass	kg of element	0.00E+00	1
Lanthanum(La) ore	Depletion of reserves, mass	kg of element	1.26E+02	2
Lithium(Li) resources	Depletion of reserves, mass	kg of element	1.40E+01	2

Table1 (continued)

Environmental good or service	Impact valued and indicator	Indicator unit	Loss of natural capital, best estimate (€$_{2025}$/indicator unit)	Loss of natural capital, uncertainty
Luthenium(Lu) ore	Depletion of reserves, mass	kg of element	1.26E+04	2
Magnesium(Mg) resources	Depletion of reserves, mass	kg of element	0.00E+00	1
Manganese(Mn) ore	Depletion of reserves, mass	kg of element	4.69E+00	2
Molybden(Mo) ore	Depletion of reserves, mass	kg of element	3.55E+03	2
Sodium(Na) salt	Depletion of reserves, mass	kg of element	0	1
Neon(Ne) gas	Depletion of reserves, mass	kg of element	0	1
Nitrogen(N) gas	Depletion of reserves, mass	kg of element	0	1
Niob(Nb) ore	Depletion of reserves, mass	kg of element	3.26E+02	2
Nickel(Ni) ore	Depletion of reserves, mass	kg of element	1.48E+02	2
Neodymium(Nd) ore	Depletion of reserves, mass	kg of element	1.45E+02	2
Osmium(Os) ore	Depletion of reserves, mass	kg of element	1.26E+08	3
Oxygen(O) gas	Depletion of reserves, mass	kg of element	0.00E+00	1
Phosphorus(P) ore	Depletion of reserves, mass	kg of element	5.96E+00	2
Lead(Pb) ore	Depletion of reserves, mass	kg of element	4.97E+02	2
Palladium(Pd) ore	Depletion of reserves, mass	kg of element	1.38E+06	3
Praseodymium(Pr) ore	Depletion of reserves, mass	kg of element	5.50E+02	2
Platinum(Pt) ore	Depletion of reserves, mass	kg of element	7.81E+06	3
Rubidium(Rb) ore	Depletion of reserves, mass	kg of element	0.00E+00	1
Rhenium(Rh) ore	Depletion of reserves, mass	kg of element	1.97E+07	3
Rhodium(Rh) ore	Depletion of reserves, mass	kg of element	1.36E+07	3
Ruthenium(Ru) ore	Depletion of reserves, mass	kg of element	6.06E+06	3
Elementary S	Depletion of reserves, mass	kg of element	2.00E-01	2
Antimony(Sb) ore	Depletion of reserves, mass	kg of element	9.77E+03	2
Scandium(Sc) ore	Depletion of reserves, mass	kg of element	2.79E+02	2
Selenium(Se) resources	Depletion of reserves, mass	kg of element	5.60E+01	5
Silicon(Si) minerals	Depletion of reserves, mass	kg of element	0.00E+00	1
Samarium(Sm) ore	Depletion of reserves, mass	kg of element	8.31E+02	2
Tin(Sn) ore	Depletion of reserves, mass	kg of element	1.98E+03	2
Strontium(Sr) minerals	Depletion of reserves, mass	kg of element	0.00E+00	1
Tantalum(Ta) ore	Depletion of reserves, mass	kg of element	4.34E+03	2
Terbium(Tb) ore	Depletion of reserves, mass	kg of element	5.58E+03	2
Tellurium(Te) resources	Depletion of reserves, mass	kg of element	3.91E+06	3
Titanium(Ti) ore	Depletion of reserves, mass	kg of element	1.02E+00	2
Thallium(Tl) ore	Depletion of reserves, mass	kg of element	3.72E+02	3
Thorium(Th) re	Depletion of reserves, mass	kg of element	3.72E+02	2
Thulium(Tm) ore	Depletion of reserves, mass	kg of element	1.30E+04	2
Uranium 235(U^{235}) ore	Depletion of reserves, mass	kg of element	2.07E+05	2
Uranium 238(U^{238}) ore	Depletion of reserves, mass	kg of element	1.46E+04	2
Vanadium(V) ore	Depletion of reserves, mass	kg of element	4.03E+01	2
Tungsten(Bi) ore	Depletion of reserves, mass	kg of element	6.33E+03	3
Yttrium(Y) ore	Depletion of reserves, mass	kg of element	1.86E+02	2
Ytterbium(Yb) ore	Depletion of reserves, mass	kg of element	1.99E+03	2
Zinc(Zn) ore	Depletion of reserves, mass	kg of element	4.96E+01	2
Zirconium(Zr) ore	Depletion of reserves, mass	kg of element	3.24E+01	3
Clean air, water, food, and good climate	Decreased healthy life years	personyears	91400	1.47
Clean air, water, food, and good climate	Severe wasting	personyears	11699.2	1.1
Clean air, water, food, and good climate	Diarrhea	personyears	17183.2	2
Clean air, water, food, and good climate	Malaria episodes	personyears	9971.74	1.1
Clean air, water, food, and good climate	Angina pectoris	personyears	7312	2
Clean air, water, food, and good climate	Cardiovascular disease	personyears	9140	3
Clean air, water, food, and good climate	Infarcts	personyears	7348.56	1.3
Clean air, water, food, and good climate	Working capacity	personhours	45.7	1.47
Clean air, water, food, and good climate	Asthma	personyears	3290.4	2
Clean air, water, food, and good climate	COPD	personyears	18280	3
Clean air, water, food, and good climate	Cancer	personyears	27420	2
Clean air, water, food, and good climate	Skin cancer	personyears	4570	1.3
Clean air, water, food, and good climate	Low vision, moderate impairment	personyears	8134.6	2
Clean air, water, food, and good climate	Poisoning	personyears	14898.2	2
Clean air, water, food, and good climate	Intellectual disability: mild	personyears	2833.4	4
Clean air, water, food, and good climate	Osteoporosis	case	116992	2
Clean air, water, food, and good climate	Renal dysfunction	case	58496	2

Emissions to water

Large global impacts of significance are shown in table 2. Exceeding concentration above a certain standard is not automatically an impact. There must be a change to environmental goods to include them. Some nutrients increase production capacity of fish why some emissions result in negative damage costs. Uncertainty factors are only determined for data on pathway level. See supplementary material. (Steen 2026)

Table 2 Loss of natural capital for emissions to water

Substance flow group	**Loss of natural capital €/kg**
BOD to freshwater	5.32E-04
BOD to seawater	1.84E-03
N-tot to freshwater	-7.80E+00
N-tot to seawater	-2.23E+01
P-tot to freshwater	-2.96E+00
As to freshwater	6.86E+03
Cd to freshwater	8.39E+00
Cr6+ to freshwater	6.77E-02
Pb to freshwater	3.01E-01
Hg to water	3.71E+01

Emissions to air

Inorganic gases

Table 3 shows new estimations of natural capital loss from emissions to air of inorganic gases. Negative values are caused by decreased global warming from secondary aerosols. In the EPS 2015 version, the negative GWP for secondary particles were not considered to be broadly accepted and two versions were published. Today there seems to be a consensus on negative GWP for secondary particles (Masson-Delmotte et al. 2021).

For CO2, knowledge from IPCC AR6 has been used as a complement to IPCC AR5 for the earlier EPS version. Besides there are some new publications on direct impacts from temperature change that have resulted in decreased social cost of carbon from 0.324 to 0.272 €/kg. The reason is mainly that the positive value of cold moderation is better assessed and overrides the negative value of heat on human health and working capacity.

Table 3 Damage cost for emissions of inorganic gases to air.

Substance flow group	Loss of natural capital, €/kg
CO2	2.72E-01
CO	6.82E-01
NOx	6.10E+00
HNO2	5.74E+00
HNO3	4.45E+00
N2O	7.16E+01
SO2	-2.30E+01
H2S	-4.32E+01
HF	-1.57E+01
HCl	-1.62E+01
NH3	-1.55E+01
Hg to air as trace element	3.71E+01
Hg to air as trace element	7.82E+04
HBr	-1.64E+01
HCN	-1.60E+01
O3	6.29E-01

Volatile organic gases

Table 4 shows the updated results for VOC. Except for methane, they are considerably higher than for the 2020d version.

Table 4 Loss of natural capital from emissions of VOC to air

Substance, flow group	Natural capital loss EUR/flow unit	Substance, flow group	Natural capital loss EUR/flow unit	Substance, flow group	Natural capital loss EUR/flow unit
Alkanes		***Aromatics***			
Methane	7.70	Benzene	30.00	I-butyraldehyde	20.07
Ethan	4.21	Toluene	30.41	Valeraldehyde	21.91
Propane	5.84	O-xylene	32.02	Glyoxal	17.68
N-butane	6.04	M-xylene	33.98	Methyl-Glyoxal	20.78
I-butane	4.09	P-xylene	33.68	Acrolein	22.45
N-pentane	6.24	Etylbenzene	32.43	Methanethiol	22.63
I-pentane	3.32	1,2,3-Trimetylbenzene	31.24	Benzaldehyde	27.55
Neopentane	1.67	1,2,4-Trimetylbenzene	32.37	Crotonaldehyde	20.01
Cyclopentane	2.42	1,3,5-Trimetylbenzene	31.30	***Esters***	
Hexane	6.83	M-ethyltoluene	33.57	Methyl formate	16.75
2-metylpentane	5.52	O-ethyltoluene	31.24	Methyl-Acetate	16.96
3-metylpentane	6.00	P-ethyltoluene	33.21	ethylacetate	17.98
2,2-Dimethylbutane	3.49	N-propylbenzene	32.26	n-Propyl acetate	18.28
2,3-Dimethylbutane	2.07	I-propylbenzene	31.30	i-Propyl acetate	17.80
N-heptane	22.51	3,5-Dimethylethylbenzene	35.41	n-butylacetate	19.17
2-Methylhexane	19.00	3,5-Diethyltoluene	35.26	2-Ethylhexyl acetate	18.34
3-Methylhexane	18.72	***Alcohols***		***Ethers***	
N-oktane	22.39	Methanol	7.73	Dimethylether	18.52
2-metylheptane	21.73	Ethanol	9.87	Ethyl methyl ether	20.01
N-nonane	22.33	Propanol	9.95	Diethyl-Ether	19.65
2-metyloktane	21.73	I-propanol	9.10	Methyl-t-Butyl-Ether	19.47
N-decane	22.21	Butanol	11.42	Diisopropylether	19.39
2-methylnonane	21.79	I-butanol	8.95	Ethyl-t-butylether	17.83
N-undecane	22.03	s-butanol	9.10	Allyl ether	20.01
N-dodecane	22.03	t-butanol	7.45	Allyl ethyl ether	20.01
Cycloalkanes		3-pentanol	9.23	***Alcohol and glycol ethers***	
Cyclohexane	18.28	2-Methylbutan-1-ol	9.14	2-Methoxyethanol	18.34
Metyl-cyclohexane	21.02	4-Ethylheptane	9.17	2-Ethoxyethanol	18.86
Cyclohexanone	18.33	3-Methylbutan-2-ol	8.89	1-Butoxypropanol	19.15
Cyclohexanol	19.21	2-Methylbutan-2-ol	7.56	2-Butoxyethanol	19.16
Alkenes		Diacetone alcohol	8.27	1-Methoxy-2-propanol	18.74
Ethene	22.83	(z)-hex-2-en-1-ol	10.17	***Carboxylic acids***	
Propene	24.03	(e)-hex-2-en-1-ol	10.17	Formic acid	16.74
1-butene	24.06	***Glycols***		Acetic Acid	17.45
2-butene	23.28	Ethylene glycol	18.83	Propanoic acid	17.45
Methylpropene	20.29	Propylene glycol	19.27	***Others***	
1-pentene	23.76	***Ketons***		Terpenes	20.35
2-pentene	24.18	Acetone	3.26	Methyl Mercaptan	20.25
2-Methylbutan-1-ol	22.33	Methyl ethyl ketone	20.07	Diethyl Sulfide	20.25
2-methyl-2-butene	23.16	Methyl i-butyl ketone	21.14	Diethyl Disulfide	18.70
3-Methylbut-1-ene	20.55	Methylpropylketone	19.82	Allyl cyanide	19.37
Hex-1-ene	21.76	Diethylketone	19.02	Hexamethyldisiloxane	19.50
Hex-2-ene	22.93	Methyl-i-propylketone	18.72	Octamethyltrisiloxane	19.46
1,3-Butadiene	21.81	Hexan-2-one	19.96	Decamethyltetrasiloxane	19.42
Dialkenes		Hexan-3-one	20.12	Dodecamethylpentasiloxane	19.40
Isoprene	14.56	Methyl-t-butylketone	18.48	Hexamethylcyclotrisiloxane	19.68
Sesquiterpenes	30.48	***Aldehydes***		Octamethylcyclotetrasiloxane	19.57
Methacrolein	22.63	Formaldehyde	18.70	Decamethylcyclopentasiloxane	19.45
Styrene	32.79	Acetaldehyde	20.96	Dodecamethylcyclohexasiloxane	19.41
Alkynes		Propionaldehyde	21.68		
Acetylene	19.05	Butyraldehyde	21.91	Median NMVOC	19.46

Halogenated organic gases

Table 5 shows the monetary values of environmental impacts of halogenated organic gases.

Table 5 monetary values of environmental impacts of halogenated organic gases

Substance, flow group	Loss of natural capital, EUR/flow unit	Substance, flow group	Loss of natural capital, EUR/flow unit	Substance, flow group	Loss of natural capital, EUR/flow unit
CFC:s		HFO-1234ze(E)	9.65E+00	HCFC-221aa	1.97E+01
CFC-11	1.64E+03	HFO-1234yf	9.65E+00	HCFC-221ab	3.91E+01
CFC-12	3.26E+03	HFO-1336mzz(E)	1.44E+01	HCFC-221ba	2.18E+01
CFC-13	4.23E+03	HFO-1336mzz(Z)	1.05E+01	HCFC-221da	5.86E+01
CFC-112	1.22E+03	HFO-1243zf	1.03E+01	HCFC-221ea	5.73E+01
CFC-112a	9.41E+02	HFO-1345zfc	1.05E+01	HCFC-222aa	2.68E+01
CFC-113	1.71E+03	3,3,4,4,5,5,6,6,6-nonafluorohex-1-ene	1.07E+01	HCFC-222ab	5.13E+01
CFC-113a	1.04E+03	3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooct-1-ene	1.09E+01	HCFC-222ac	1.43E+02
CFC-114	2.46E+03	3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodec-1-ene	1.12E+01	HCFC-222ba	2.64E+01
CFC-114a	1.90E+03	3,3,3-trifluoro-2-(trifluoromethyl)prop-1-ene	1.15E+01	HCFC-222bb	5.22E+01
CFC-115	2.50E+03	1,1,2,2,3,3-hexafluorocyclopentane	4.28E+01	HCFC-222ca	3.01E+01
E-R316c	1.12E+03	1,1,2,2,3,3,4-heptafluorocyclopentane	7.19E+01	HCFC-222da	9.34E+01
Z-R316c	1.49E+03	1,3,3,4,4,5,5-heptafluorocyclopentene	2.38E+01	HCFC-222db	9.11E+01
CFC 1112	1.98E+01	(4s,5s)-1,1,2,2,3,3,4,5-octafluorocyclopentane	7.94E+01	HCFC-222ea	8.61E+01
CFC 1112a	2.00E+01	HFO-1438ezy(E)	1.46E+01	HCFC-223aa	2.80E+01
HFC:s		HFO-1447fz	1.28E+01	HCFC-223ab	7.46E+01
HFC-23	3.77E+03	1,3,3,4,4-pentafluorocyclobutene	3.70E+01	HCFC-223ac	1.97E+02
HFC-32	2.03E+02	3,3,4,4-tetrafluorocyclobutene	1.99E+01	HCFC-223ba	3.81E+01
HFC-41	3.75E+01	**HCFC:s**		HCFC-223bb	6.52E+01
HFC-125	9.75E+02	HCFC-21	4.45E+01	HCFC-223bc	1.95E+02
HFC-134	3.30E+02	HCFC-22	5.13E+02	HCFC-223ca	3.65E+01
HFC-134a	4.01E+02	HCFC-31	2.35E+01	HCFC-223cb	7.81E+01
HFC-143	9.79E+01	HCFC-121	1.86E+01	HCFC-223da	1.53E+02
HFC-143a	1.51E+03	HCFC-121a	4.54E+01	HCFC-223db	1.17E+02
HFC-152	9.36E+00	HCFC-122	3.09E+01	HCFC-223ea	1.36E+02
HFC-152a	4.66E+01	HCFC-122a	7.41E+01	HCFC-223eb	1.32E+02
HFC-161	5.49E+00	HCFC-122b	1.92E+02	HCFC-224aa	7.30E+01
HFC-227ca	7.79E+02	HCFC-123	3.80E+01	HCFC-224ab	2.68E+02
HFC-227ea	9.41E+02	HCFC-123a	1.15E+02	HCFC-224ba	3.84E+01
HFC-236cb	3.56E+02	HCFC-123b	2.99E+02	HCFC-224bb	1.01E+02
HFC-236ea	3.95E+02	HCFC-124	1.60E+02	HCFC-224bc	2.71E+02
HFC-236fa	2.26E+03	HCFC-124a	5.43E+02	HCFC-224ca	5.17E+01
HFC-245ca	2.10E+02	HCFC-131	1.33E+01	HCFC-224cb	4.58E+01
HFC-245cb	1.42E+03	HCFC-131a	5.17E+01	HCFC-224cc	3.04E+02
HFC-245ea	7.24E+01	HCFC-131b	3.84E+01	HCFC-224da	2.81E+02
HFC-245eb	9.08E+01	HCFC-132	3.78E+01	HCFC-224db	2.13E+02
HFC-245fa	2.57E+02	HCFC-132a	2.45E+01	HCFC-224ea	2.27E+02
HFC-263fb	2.62E+01	HCFC-132b	1.22E+02	HCFC-224eb	1.72E+02
HFC-272ca	1.63E+02	HCFC-132c	9.57E+01	HCFC-225aa	2.64E+02
HFC-329p	7.59E+02	HCFC-133	7.78E+01	HCFC-225ba	1.03E+02
HFC-365mfc	2.45E+02	HCFC-133a	1.08E+02	HCFC-225bb	4.17E+02
HFC-43-10mee	4.24E+02	HCFC-133b	2.06E+02	HCFC-225ca	5.56E+01
HFO-1123	7.91E+00	HCFC-141	2.00E+01	HCFC-225cb	1.68E+02
HFO-1132a	8.15E+00	HCFC-141a	1.16E+01	HCFC-225cc	4.01E+02
HFO-1141	8.38E+00	HCFC-141b	2.33E+02	HCFC-225da	4.05E+02
HFO-1225ye(Z)	8.69E+00	HCFC-142	5.35E+01	HCFC-225ea	4.28E+02
HFO-1225ye(E)	8.86E+00	HCFC-142a	3.65E+01	HCFC-225eb	3.22E+02
HFO-1234ze(Z)	9.14E+00	HCFC-142b	6.07E+02	HCFC-226ba	4.06E+02
		HCFC-151	1.16E+01	HCFC-226ca	1.43E+02
		HCFC-151a	2.31E+01	HCFC-226cb	6.43E+02
				HCFC-226da	5.98E+02

Table 5 (continued)

Substance, flow group	Loss of natural capital, EUR/flow unit	Substance, flow group	Loss of natural capital, EUR/flow unit	Substance, flow group	Loss of natural capital, EUR/flow unit	Substance, flow group	Loss of natural capital, EUR/flow unit
HCFC-226ea	6.60E+02	HCFC-234ca	8.31E+01	HCFC-243ab	2.11E+02	HCFC-252ea	7.17E+01
HCFO-1233zd(E)	2.34E+01	HCFC-234cb	6.33E+01	HCFC-243ba	9.83E+01	HCFC-252eb	6.59E+01
HCFO-1233zd(Z)	2.28E+01	HCFC-234cc	2.53E+02	HCFC-243bb	8.88E+01	HCFC-252ec	7.55E+01
(e)-1-chloro-2-fluoroethene	2.29E+01	HCFC-234cd	1.96E+02	HCFC-243bc	4.39E+02	HCFC-252fa	7.76E+01
HCFC-231aa	3.07E+01	HCFC-234da	8.22E+01	HCFC-243ca	9.85E+01	HCFC-252fb	6.84E+01
HCFC-231ab	4.38E+01	HCFC-234db	1.69E+02	HCFC-243cb	6.88E+01	HCFC-252fc	7.60E+01
HCFC-231ac	4.93E+01	HCFC-234ea	5.05E+01	HCFC-243cc	4.24E+02	HCFC-252fd	7.25E+01
HCFC-231ba	2.87E+01	HCFC-234eb	9.60E+01	HCFC-243da	7.92E+01	HCFC-253ba	1.19E+02
HCFC-231da	2.95E+01	HCFC-234ec	1.63E+02	HCFC-243db	6.82E+01	HCFC-253bb	2.35E+02
HCFC-231db	3.81E+01	HCFC-234fa	9.24E+02	HCFC-243dc	8.88E+01	HCFC-253ca	1.30E+02
HCFC-231ea	3.18E+01	HCFC-234fb	6.21E+02	HCFC-243ea	7.51E+01	HCFC-253cb	1.38E+02
HCFC-231fa	1.18E+02	HCFC-235ba	2.24E+02	HCFC-243eb	6.18E+01	HCFC-253da	8.58E+01
HCFC-232aa	4.74E+01	HCFC-235bb	1.99E+02	HCFC-243ec	7.95E+01	HCFC-253db	7.72E+01
HCFC-232ab	3.67E+01	HCFC-235ca	2.37E+02	HCFC-243ed	9.18E+01	HCFC-253ea	8.21E+01
HCFC-232ac	6.82E+01	HCFC-235cb	1.36E+02	HCFC-243fa	5.93E+01	HCFC-253eb	8.55E+01
HCFC-232ad	6.31E+01	HCFC-235cc	4.15E+02	HCFC-243fb	1.00E+02	HCFC-253ec	8.77E+01
HCFC-232ba	3.84E+01	HCFC-235da	2.00E+02	HCFC-243fc	1.78E+02	HCFC-253fa	1.02E+02
HCFC-232bb	6.89E+01	HCFC-235ea	1.96E+02	HCFC-244ba	1.46E+02	HCFC-253fb	7.86E+01
HCFC-232bc	8.22E+01	HCFC-235eb	1.21E+02	HCFC-244bb	4.66E+02	HCFC-253fc	9.81E+01
HCFC-232ca	3.41E+01	HCFC-235fa	1.42E+03	HCFC-244ca	1.68E+02	HCFC-261aa	7.35E+01
HCFC-232cb	9.65E+01	HCFC-241aa	5.31E+01	HCFC-244cb	1.27E+02	HCFC-261ba	8.64E+01
HCFC-232da	3.85E+01	HCFC-241ab	4.60E+01	HCFC-244cc	9.29E+02	HCFC-261da	6.62E+01
HCFC-232db	5.01E+01	HCFC-241ac	1.21E+02	HCFC-244da	1.27E+02	HCFC-261db	6.83E+01
HCFC-232dc	6.70E+01	HCFC-241ba	4.83E+01	HCFC-244db	9.49E+01	HCFC-261ea	6.80E+01
HCFC-232ea	3.84E+01	HCFC-241bb	1.61E+02	HCFC-244ea	1.01E+02	HCFC-261eb	6.74E+01
HCFC-232eb	5.65E+01	HCFC-241da	4.55E+01	HCFC-244eb	8.54E+01	HCFC-261fa	7.06E+01
HCFC-232fa	2.11E+02	HCFC-241db	4.62E+01	HCFC-244ec	1.22E+02	HCFC-261fb	6.79E+01
HCFC-232fb	2.18E+02	HCFC-241dc	4.84E+01	HCFC-244fa	9.99E+01	HCFC-261fc	7.60E+01
HCFC-233aa	6.83E+01	HCFC-241ea	4.43E+01	HCFC-244fb	2.87E+02	HCFC-262ba	1.25E+02
HCFC-233ab	6.96E+01	HCFC-241eb	5.26E+01	HCFC-251aa	6.38E+01	HCFC-262ca	1.17E+02
HCFC-233ac	1.04E+02	HCFC-241fa	4.71E+01	HCFC-251ab	7.33E+01	HCFC-262da	7.40E+01
HCFC-233ba	6.41E+01	HCFC-241fb	6.08E+01	HCFC-251ba	6.73E+01	HCFC-262db	7.40E+01
HCFC-233bb	4.78E+01	HCFC-242aa	6.73E+01	HCFC-251bb	6.59E+01	HCFC-262ea	7.45E+01
HCFC-233bc	1.29E+02	HCFC-242ab	6.38E+01	HCFC-251da	6.08E+01	HCFC-262eb	7.62E+01
HCFC-233bd	1.07E+02	HCFC-242ac	2.04E+02	HCFC-251db	5.78E+01	HCFC-262fa	7.70E+01
HCFC-233ca	4.88E+01	HCFC-242ba	6.99E+01	HCFC-251dc	6.17E+01	HCFC-262fb	7.96E+01
HCFC-233cb	1.23E+02	HCFC-242bb	5.59E+01	HCFC-251ea	5.96E+01	HCFC-262fc	9.57E+01
HCFC-233cc	1.54E+02	HCFC-242bc	2.17E+02	HCFC-251eb	6.51E+01	HCFC-271ba	1.56E+02
HCFC-233da	4.18E+01	HCFC-242ca	5.79E+01	HCFC-251fa	5.87E+01	HCFC-271da	6.95E+01
HCFC-233db	7.69E+01	HCFC-242cb	3.15E+02	HCFC-251fb	6.13E+01	HCFC-271ea	7.00E+01
HCFC-233dc	1.01E+02	HCFC-242da	6.16E+01	HCFC-251fc	6.34E+01	HCFC-271fa	7.03E+01
HCFC-233ea	4.67E+01	HCFC-242db	5.25E+01	HCFC-252aa	7.92E+01	HCFC-271fb	7.42E+01
HCFC-233eb	7.35E+01	HCFC-242dc	6.30E+01	HCFC-252ab	1.30E+02	**Unsaturated HFOs**	
HCFC-233ec	1.11E+02	HCFC-242dd	5.69E+01	HCFC-252ba	8.12E+01	HFO-1123	6.89E+01
HCFC-233fa	4.26E+02	HCFC-242ea	5.32E+01	HCFC-252bb	1.03E+02	HFO-1132a	6.91E+01
HCFC-234aa	1.45E+02	HCFC-242eb	6.38E+01	HCFC-252ca	9.16E+01	HFO-1141	6.93E+01
HCFC-234ab	1.04E+02	HCFC-242ec	7.20E+01	HCFC-252cb	7.71E+01	HFO-1234ye(E)	6.96E+01
HCFC-234ba	9.68E+01	HCFC-242fa	5.60E+01	HCFC-252da	6.84E+01	HFO-1234ye(Z)	6.98E+01
HCFC-234bb	1.25E+02	HCFC-242fb	7.50E+01	HCFC-252db	7.15E+01	HFO-1225ye(E)	7.00E+01
HCFC-234bc	2.03E+02	HCFC-243aa	9.11E+01	HCFC-252dc	7.14E+01	HFO-1225ye(Z)	7.03E+01

Table 5 (continued)

Substance, flow group	**Loss of natural capital, EUR/flow unit**	**Substance, flow group**	**Loss of natural capital, EUR/flow unit**
2,3,3,4,4-pentafluorocyclobut-1-ene	8.71E+01	**Fully Fluorinated Species**	
HFO-1234ze(E)	7.08E+01	Nitrogen trifluoride	4.55E+03
HFO-1234ze(Z)	7.10E+01	Pentadecafluorotriethylamine	2.70E+03
3,3,4,4-tetrafluorocyclobut-1-ene	7.40E+01	Perfluorotripropylamine	2.37E+03
HFO-1234yf	7.14E+01	Heptacosafluorotributylamine	2.23E+03
HFO-1261zf	7.16E+01	Perfluorotripentylamine	1.92E+03
HFO-1234yc	7.19E+01	Heptafluoroisobutyronitrile	7.43E+02
HFO-1225zc	7.21E+01	Sulphur hexafluoride	6.35E+03
HFO-1234zc	7.23E+01	Trifluromethylsulfurpentafluoride	4.84E+03
HFO-1336mzz(E)	7.67E+01	Sulfuryl fluoride	1.23E+03
HFO-1336mzz(Z)	7.33E+01	PFC-14	1.95E+03
HFO-1243zf	7.30E+01	PFC-116	3.25E+03
HFO-1345zf	7.33E+01	PFC-218	2.44E+03
HFO-1438mzz(E)	7.35E+01	Hexafluorocyclobutene	6.23E+01
HFO-1447zf	7.37E+01	PFC-C-318	2.68E+03
3,3,4,4,5,5,6,6,6-Nonafluorohex-1-ene	7.39E+01	PFC-31-10	2.63E+03
HFO-174-13fz	7.42E+01	Octafluorocyclopentene	5.05E+01
HFO-194-17fz	7.44E+01	PFC-41-12	2.43E+03
HFO-1438ezy(E)	7.75E+01	PFC-51-14	2.27E+03
Chlorocarbons and Hydrochlorocarbons		PFC-61-16	2.22E+03
Methyl chloroform	1.19E+02	PFC-71-18	2.18E+03
CCl4	6.63E+02	PFC-91-18	1.98E+03
Methyl chloride	7.68E+01	1,1,2,2,3,3,4,4,4a,5,5,6,6,7,7,8,8,8a-octadecafluoronaphthalene	2.06E+03
Methylenechloride	7.85E+01	1,1,2,2,3,3,4,4,4a,5,5,6,6,7,7,8,8,8a-octadecafluoronaphthalene	1.88E+03
Chloroform	8.13E+01	PFC-1114	3.21E+01
Chloroethane	7.92E+01	PFC-1216	3.23E+01
1,2-dichloroethane	7.65E+01	1,1,2,3,4,4-hexafluorobuta-1,3-diene	3.25E+01
1,1,2-trichloroethene	7.96E+01	Octafluoro-1-butene	3.28E+01
1,1,2,2-tetrachloroethene	8.14E+01	Octafluoro-2-butene	3.35E+01
2-chloropropane	8.01E+01	**Halog. Alcohols, Ethers, Furans, Aldehydes and Ketones**	
1-chlorobutane	8.02E+01	HFE-125	3.75E+03
Bromocarbons and Halons		HFE-134	1.76E+03
Methyl bromide	3.60E+01	HFE-143a	1.94E+02
Methylenebromide	2.69E+01	HFE-227ea	1.99E+03
HBFC-12B1	1.55E+02	HCFE-235ca2	2.05E+02
Halon-1201	1.36E+02	HCFE-235da2	1.75E+02
Halon-1202	1.13E+02	HFE-236ea2	7.08E+02
Halon-1211	6.72E+02	HFE-236fa	3.21E+02
Halon-1301	2.19E+03	HFE-245cb2	2.29E+02
Halon-2301	8.88E+01	HFE-245fa1	2.78E+02
Halon-2311	6.58E+01	HFE-245fa2	2.64E+02
Halon-2401	1.14E+02	2,2,3,3,3-pentafluoropropan-1-ol	4.49E+01
Halon-2402	8.30E+02	HFE-254cb1	1.21E+02
Tribromomethane	8.08E+01	HFE-263mf	3.70E+01
Halon-1011	4.52E+01	HFE-263m1	4.43E+01
Bromoethane	3.00E+01	3,3,3-trifluoropropan-1-ol	3.71E+01
1,2-dibromoethane	2.80E+01	HFE-329mcc2	1.02E+03
1-bromopropane	2.78E+01	HFE-338mmz1	8.28E+02
2-bromopropane	2.80E+01	HFE-338mcf2	3.08E+02
		HFE-347mmz1	8.85E+01
		HFE-347mcc3	1.88E+02

Table 5 (continued)

Substance, flow group	Loss of natural capital, EUR/flow unit	Substance, flow group	Loss of natural capital, EUR/flow unit
HFE-347mcf2	2.89E+02	HFE-329me3	1.19E+03
HFE-347pcf2	2.93E+02	3,3,4,4,5,5,6,6,7,7,7-undecafluoroheptan-1-ol	4.60E+01
HFE-347mmy1	1.41E+02	3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-pentadecafluorononan-1-ol	4.62E+01
HFE-356mec3	1.08E+02	3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-nonadecafluoroundec	4.64E+01
HFE-356mff2	4.55E+01	2-chloro-1,1,2-trifluoro-1-methoxyethane	8.19E+01
HFE-356pcf2	2.55E+02	PFPMIE (perfluoropolymethylisopropyl ether)	2.72E+03
HFE-356pcf3	1.65E+02	HFE-216	4.70E+01
HFE-356pcc3	1.12E+02	Perfluoroethylformate	2.02E+02
HFE-356mmz1	4.22E+01	2,2,2-trifluoroethylformate	6.17E+01
HFE-365mcf3	4.08E+01	Formic acid;1,1,1,3,3,3-hexafluoropropan-2-ol	1.18E+02
HFE-374pc2	4.38E+01	Ethenyl 2,2,2-trifluoroacetate	4.79E+01
4,4,4-trifluorobutan-1-ol	4.08E+01	Ethyl 2,2,2-trifluoroacetate	4.86E+01
2,2,3,3,4,4,5,5-octafluorocyclopentan-1-ol	4.46E+01	Prop-2-enyl 2,2,2-trifluoroacetate	4.84E+01
HFE-43-10pccc124	8.78E+02	Methyl 2,2,2-trifluoroacetate	7.00E+01
HFE-449s1 (HFE 7100)	1.61E+02	2,2,3,3,4,4,4-heptafluorobutan-1-ol	5.83E+01
n-HFE-7100	1.83E+02	1,1,2-trifluoro-2-(trifluoromethoxy)ethane	3.77E+02
i-HFE-7100	1.56E+02	1-ethoxy-1,1,2,3,3,3-hexafluoropropane	5.62E+01
HFE-569sf2	5.80E+01	1,1,1,2,2,3,3-heptafluoro-3-(1,2,2,2-tetrafluoroethoxy)propane	1.77E+03
i-HFE-7200	5.13E+01	2,2,3,3-tetrafluoropropan-1-ol	5.35E+01
HFE-7300	1.48E+02	2,2,3,4,4,4-hexafluorobutan-1-ol	5.79E+01
HFE-7500	4.63E+01	1,1,2,2-tetrafluoro-3-methoxypropane	5.07E+01
HFE-236ca12 (HG-10)	1.62E+03	1,1,1,2,2,4,5,5,5-nonafluoro-4-(trifluoromethyl)pentan-3-one	5.05E+01
HFE-338pcc13 (HG-01)	9.06E+02	3,3,3-trifluoropropanal	5.07E+01
1,1,1,3,3,3-hexafluoropropan-2-ol	9.71E+01	2-fluoroethanol	5.11E+01
HG-02	1.53E+03	2,2-difluoroethanol	5.28E+01
HG-03	1.43E+03	2,2,2-trifluoroethanol	6.07E+01
Fluroxene	4.43E+01	HG-04	1.19E+03
2-ethoxy-3,3,4,4,5-pentafluorotetrahydro-2,5-bis[1,2,2,2-tetrafluoro-1-(trifluoromethyl)ethyl]-furan	5.71E+01	Methyl-perfluoroheptene-ethers	5.58E+01
Difluoro(methoxy)methane	8.01E+01	1,1,1-trifluoropropan-2-one	5.29E+01
HG’-01	9.75E+01	1,1,1-trifluorobutan-2-one	5.23E+01
HG’-02	1.05E+02	1-chloro-2-ethenoxyethane	5.59E+01
HG’-03	1.02E+02	Octafluorooxolane	3.67E+03

Particles

Table 6 shows loss of natural capital from particles emitted to air

Table 6 Natural capital loss from particles emitted to air

Flow group	Natural capital loss, EUR/kg
PM2.5	7.97E+01
TSP	6.44E+01
As	8.85E+01
Cd	1.13E+02
Cr	9.04E+02
Cu	7.97E+01
Ni	9.68E+01
Pb	2.19E+04
PAH	9.51E+01

Emissions to land

Pesticides

Table 7 shows loss of natural capital when pesticides are applied to land areas

Table 7 loss of natural capital for pesticides applied to land areas

Substance flow group	Loss of natural capital, €/kg	Substance flow group	Loss of natural capital, €/kg	Substance flow group	Loss of natural capital, €/kg
2,3,6-TBA [ISO]	2.40E-01	Carbaryl [ISO]	5.09E-01	Dimethenamid [ISO]	3.87E-01
2,4-D [ISO]	2.23E-01	Carbofuran [ISO]	3.12E+01	Dimethipin [ISO]	1.97E-01
2,4-DB	1.17E-01	Carbosulfan [ISO]	9.35E-01	Dimethoate [ISO]	1.36E+00
2-Napthyloxyacetic acid [ISO]	2.60E-01	Cartap [ISO]	6.79E-01	Dimethylarsinic acid [C]	4.42E+02
3-Chloro-1,2-propanediol	6.01E+00	Chloralose [C]	7.37E-01	Diniconazole [ISO]	3.29E-01
4-CPA [ISO]	1.84E-01	Chlordane [ISO]	7.81E-01	Dinobuton [ISO]	2.65E+00
Acephate [ISO]	2.23E-01	Chlorethoxyfos [ISO]	7.86E+01	Dinocap [ISO]	2.04E-01
Acifluorfen [ISO]	1.22E+00	Chlorfenapyr [ISO]	1.33E+00	Dinoterb [ISO]	6.01E+00
Acrolein [C]	6.01E+00	Chlorfenvinphos [ISO]	1.66E+01	Diphacinone [ISO]	1.04E+02
Alachlor [ISO]	1.68E-01	Chlormephos [ISO]	2.31E+01	Diphenamid [ISO]	2.28E-01
Alanycarb [ISO]	5.05E-01	Chlormequat (chloride) [ISO]	1.74E-01	Diquat [ISO]	7.30E-01
Aldicarb [ISO]	1.88E+02	Chloroacetic acid [C]	1.73E+00	Disulfoton [ISO]	1.61E+00
Allethrin [ISO]	2.28E-01	Chlorophacinone [ISO]	7.44E+01	Dithianon [ISO]	2.88E-01
Allyl alcohol [C]	2.44E+00	Chlorphonium chloride [ISO]	1.34E+00	DNOC [ISO]	6.25E+00
Alpha-cypermethrin [ISO]	1.98E+00	Chlorpyrifos [ISO]	1.23E+00	Dodine [ISO]	2.37E-01
Ametryn [ISO]	3.36E-01	Clomazone [ISO]	1.14E-01	Edifenphos [ISO]	2.20E+00
Amitraz [ISO]	1.95E-01	Copper hydroxide [C]	9.12E+01	Endosulfan [ISO]	8.69E+00
Anilofos [ISO]	8.67E-01	Copper oxychloride [C]	8.34E+01	Endothal-sodium [(ISO)]	4.34E+00
Azaconazole	5.07E-01	Copper sulfate [C]	5.59E+01	EPN	8.03E+00
Azamethiphos [ISO]	6.00E+00	Coumaphos [ISO]	1.25E+01	EPTC [ISO]	2.04E-01
Azinphos-ethyl [ISO]	2.29E+01	Coumatetralyl [ISO]	5.21E+00	Esfenvalerate [ISO]	4.80E-01
Azinphos-methyl [ISO]	1.36E+01	Cuprous oxide [C]	1.24E+02	Ethiofencarb [ISO]	8.09E-01
Azocyclotin [ISO]	5.42E+02	Cyanazine [ISO]	1.05E+00	Ethion [ISO]	1.30E+01
Bendiocarb [ISO]	3.90E+00	Cyanophos [ISO]	1.51E+00	Ethoprophos [ISO]	3.38E+00
Benfuracarb [ISO]	1.50E+00	Cyfluthrin [ISO]	4.53E-01	Famphur	6.18E+00
Bensulide [ISO]	7.16E-01	Cyhalothrin [ISO]	3.19E+00	Fenamiphos [ISO]	5.85E+01
Bensultap [ISO]	2.01E-01	Cyhexatin [ISO]	6.11E+02	Fenazaquin [ISO]	1.15E+00
Bentazone [ISO]	2.10E-01	Cymoxanil [ISO]	1.42E-01	Fenitrothion [ISO]	8.86E-01
Beta-cyfluthrin [ISO]	7.80E-01	Cypermethrin [ISO]	2.72E+00	Fenobucarb	4.46E-01
Bifenthrin	2.13E+00	Cyphenothrin [(1R)-isomers][ISO]	4.91E-01	Fenothiocarb [ISO]	1.61E-01
Bilanafos sodium [ISO]	1.00E+00	Cyproconazole	4.46E-01	Fenpropathrin [ISO]	8.68E+00
Bioallethrin [C]	2.28E-01	Dazomet [ISO]	5.27E-01	Fenpropidin [ISO]	1.08E-01
Blasticidin-S	2.75E+00	DDT [ISO]	8.01E-01	Fenpyroximate [ISO]	6.37E-01
Brodifacoum [ISO]	3.00E+02	Deltamethrin [ISO]	6.25E-02	Fenthion [ISO]	1.58E+00
Bromadiolone [ISO]	1.39E+02	Demeton-S-methyl [ISO]	6.07E+00	Fentin acetate[(ISO)]	5.77E+02
Bromethalin [ISO]	6.15E+01	Diazinon [ISO]	7.53E-01	Fentin hydroxide[(ISO)]	6.42E+02
Bromoxynil [ISO]	6.56E-01	Dicamba [ISO]	6.10E-02	Fenvalerate [ISO]	2.22E+00
Bromuconazole	4.28E-01	Dichlorobenzene [C]	7.81E-02	Ferimzone [ISO]	2.97E-01
Bronopol	4.96E-01	Dichlorophen [ISO]	1.04E-01	Fipronil	3.45E+00
Butamifos [ISO]	8.05E-01	Dichlorprop [ISO]	1.95E-01	Flocoumafen	6.25E+02
Butocarboxim [ISO]	1.05E+00	Dichlorvos [ISO]	1.00E+01	Fluchloralin [ISO]	1.18E+00
Butoxycarboxim [ISO]	3.70E-01	Diclofop [ISO]	2.66E-01	Flucythrinate [ISO]	2.92E+00
Butralin [ISO]	6.25E-02	Dicofol [ISO]	2.70E-01	Flufenacet [ISO]	1.68E+00
Butroxydim [ISO]	9.55E-02	Dicrotophos [ISO]	9.45E+00	Fluoroacetamide [C]	2.89E+01
Butylamine [ISO]	4.20E-01	Difenacoum [ISO]	8.68E+01	Fluoroglycofen	1.06E+00
Cadusafos [ISO]	2.68E+00	Difenoconazole [ISO]	1.07E-01	Flurprimidol [ISO]	1.50E+00
Calcium arsenate [C]	3.14E+02	Difenzoquat [ISO]	3.32E-01	Flusilazole	1.08E+00
Calcium cyanide [C]	4.00E+00	Difethialone [ISO]	2.79E+02	Flutriafol [ISO]	1.00E+00
Captafol [ISO]	4.62E-02	Dimepiperate [ISO]	1.89E-01	Fluxofenim [ISO]	1.52E+00
		Dimethachlor [ISO]	9.76E-02	Fomesafen [ISO]	1.05E+00

Table 7 (continued)

Substance flow group	Loss of natural capital, €/kg	Substance flow group	Loss of natural capital, €/kg	Substance flow group	Loss of natural capital, €/kg
Formetanate hydrochloride	7.81E+00	Metolcarb [ISO]	5.83E-01	Pyroquilon [ISO]	4.86E-01
Fuberidazole [ISO]	3.12E-01	Metribuzin [ISO]	1.72E-01	Quinalphos [ISO]	6.65E+00
Furalaxyl [ISO]	1.66E-01	Mevinphos [ISO]	5.29E+01	Quinoclamine [ISO]	1.15E-01
Furathiocarb	2.96E+00	Molinate [ISO]	4.57E-01	Quizalofop	2.65E-02
Gamma-HCH [ISO], Lindane	8.82E-01	Monocrotophos [ISO]	2.03E+01	Quizalofop-p-tefuryl [ISO]	1.54E-01
Glufosinate-ammonium	1.03E+00	Myclobutanil	9.76E-02	Rotenone [C]	2.60E+00
Guazatine	5.58E-01	Nabam [ISO]	4.95E-01	Simetryn [ISO]	2.38E-01
Haloxyfop	1.18E+00	Naled [ISO]	2.18E+00	Sodium arsenite [C]	4.73E+02
HCH [ISO], (Lindane)	1.12E+00	Nicotine [ISO]	3.12E+00	Sodium chlorate [ISO]	2.79E-02
Heptenophos [ISO]	2.20E+00	Nitrapyrin [ISO]	1.66E-01	Sodium cyanide [C]	2.73E+01
Hexachlorobenzene [ISO]	1.56E-02	Nuarimol [ISO]	5.00E-01	Sodium fluoroacetate [C]	1.56E+03
Hexazinone [ISO]	9.24E-02	Octhilinone [ISO]	3.14E-01	Spiroxamine [ISO]	3.12E-01
Hydramethylnon	1.75E+00	Omethoate [ISO]	6.10E+00	Strychnine [C]	3.63E+01
Imazalil [ISO]	6.88E-01	Oxadixyl	8.40E-02	Sulfluramid [ISO]	4.60E+00
Imidacloprid [ISO]	3.81E-01	Oxamyl [ISO]	6.25E+01	Sulfotep [ISO]	3.18E+01
Iminoctadine [ISO]	5.58E-01	Oxydemeton-methyl [ISO]	6.01E+00	TCA [ISO] (acid)	4.70E-02
Indoxacarb [ISO]	1.06E+00	Paclobutrazol [ISO]	1.20E-01	Tebuconazole [ISO]	4.66E-02
Ioxynil [ISO]	2.32E+01	Paraquat [ISO]	1.56E+00	Tebufenpyrad [ISO]	2.62E-01
Ioxynil octanoate [(ISO)]	1.71E+01	Parathion [ISO]	7.87E+01	Tebupirimfos [ISO*]	6.57E+01
Iprobenfos	9.23E-01	Parathion-methyl [ISO]	2.67E+01	Tebuthiuron [ISO]	2.71E-01
Isoprocarb [ISO]	3.47E-01	Paris green [C]	3.97E+02	Tefluthrin	9.33E+00
Isoprothiolane [ISO]	1.75E-01	Pebulate [ISO]	2.01E-01	Terbufos [ISO]	9.83E+01
Isoproturon [ISO]	8.55E-02	Pendimethalin [ISO]	3.35E-02	Terbumeton [ISO]	3.61E-01
Isouron [ISO]	2.48E-01	Pentachlorophenol [ISO]	5.78E+00	Tetraconazole [ISO]	1.58E+00
Isoxathion [ISO]	2.01E+00	Permethrin [ISO]	7.10E-02	Thallium sulfate [C]	3.52E+03
Lambda-cyhalothrin	3.19E+00	Phenthoate [ISO]	2.82E+00	Thiacloprid	3.77E-01
Lead arsenate [C]	4.74E+02	Phenylmercury acetate [ISO]	4.65E+04	Thiobencarb [ISO]	1.95E-01
MCPA [ISO]	1.62E-01	Phorate [ISO]	1.57E+02	Thiocyclam hydrogen oxalate	8.72E-01
MCPA-thioethyl [ISO]	2.24E-01	Phosalone [ISO]	2.37E+00	Thiodicarb [ISO]	2.42E+00
MCPB [ISO]	2.30E-01	Phosmet [ISO]	2.31E+00	Thiofanox [ISO]	1.84E+01
Mecarbam [ISO]	5.64E+00	Phosphamidon	9.59E+00	Thiometon [ISO]	3.98E+00
Mecoprop [ISO]	1.69E-01	Phoxim [ISO]	6.80E-01	Thiram [ISO]	3.85E-01
Mecoprop-P [ISO]	1.49E-01	Piperophos [ISO]	1.04E+00	Tralkoxydim [ISO]	1.67E-01
Mefluidide [ISO]	1.35E+00	Pirimicarb [ISO]	1.56E+00	Tralomethrin	1.58E+00
Mepiquat [ISO]	5.78E-01	Pirimiphos-methyl [ISO]	7.51E-01	Triadimefon [ISO]	4.30E-01
Mercuric chloride [ISO]	5.79E+04	Prallethrin [ISO]	2.84E-01	Triadimenol [ISO]	4.11E-02
Mercuric oxide [ISO]	7.24E+04	Prochloraz [ISO]	9.76E-02	Triazamate [ISO]	2.58E+00
Mercurous chloride [C]	6.64E+04	Profenofos [ISO]	9.44E-01	Triazophos [ISO]	3.35E+00
Metalaxyl [ISO]	2.33E-01	Propachlor [ISO]	2.20E-01	Trichlorfon [ISO]	1.07E+00
Metaldehyde [ISO]	5.52E-01	Propanil [ISO]	4.26E-01	Triclopyr [ISO]	8.22E-02
Metamitron [ISO]	1.08E-01	Propetamphos [ISO]	2.76E+00	Tricyclazole [ISO]	6.58E-01
Metam-sodium [(ISO)]	4.46E-01	Propiconazole [ISO]	1.03E-01	Tridemorph [ISO]	2.40E-01
Metconazole [ISO]	1.07E-01	Propoxur [ISO]	3.81E+00	Triflumizole	1.37E+00
Methacrifos [ISO]	1.03E+00	Prosulfocarb [ISO]	1.11E-01	Uniconazole [ISO]	8.72E-02
Methamidophos [ISO]	2.22E+01	Prothiofos [ISO]	7.51E-01	Vamidothion [ISO]	3.13E+00
Methasulfocarb [ISO]	2.19E+00	Pyraclofos [ISO]	1.19E+00	Warfarin [ISO]	9.76E+01
Methidathion [ISO]	8.44E+00	Pyrazophos [ISO]	1.23E+00	XMC	6.37E-01
Methiocarb [ISO]	7.84E+00	Pyrazoxyfen [ISO]	9.50E-02	Xylylcarb	5.38E-01
Methomyl [ISO]	4.92E+00	Pyrethrins [C]	2.08E-01	Zeta-cypermethrin [ISO]	1.82E+00
Methyl isothiocyanate [ISO]	2.26E+00	Pyridaben [ISO]	2.92E-01	Zinc phosphide [C]	4.30E+01
Methylarsonic acid [ISO]	4.36E+02	Pyridaphenthion	9.30E-01	Ziram [ISO]	1.12E+01

Noise

In the EPS 2020 version (Steen and Rydberg 2020), the monetary value for noise was determined for different noise levels per car km. In this updated version noise are valued per noisekm measured as emitted energy, i.e. 10^(dBA/10)*km. This resulted in a monetary value of 1.07E-08 €/10^(dBA/10)*km. The calculation s shown in table 8 and explained further n the supplementary material.

Table 8 Monetary value of environmental impacts of noise

Flow group	Flow unit	Impact indicator	Pathway	Extension, impact units	Extension, uncer-tainty	Contribution per noisekm, best estimate	Contribution uncertainty	Characterization factor, impact units/ emission unit	Loss of natural capital €/flow unit
Noisekm	10^(dBA/10)*km	DALY	sleep disturbance	1.92E+07	2	6.10E-21	1.4	1.17E-13	1.07E-08

Land use

Land use values are shown in table 9. The same method for calculation is used as for the 2020 version, but new red-list data from IUCN and new assessments of temperature related health impacts in cities (Wang et al. 2025) are used. For biodiversity impacts, an alternative would have been to follow the method recommended by GLAM (UNEP/SETAC 2016) and use "potentially disappeared fraction of species" (PDF) to allocate the total value of biodiversity to different activities. This method was developed by Caudhary (Chaudhary et al. 2015) and is more sophisticated in that it assesses impacts on different taxa and threat levels. But it includes weighting when aggregating impacts on different taxa and on different threat levels. It requires input data that is difficult to obtain, and it only considers impact on biodiversity from land use. There is also an inherent weighting between different taxa in the EPS method in that that it gives equal weight to all red listed species. But that weighting may be seen as representing people's concern for different species as the process of adding species to the list is based on voluntary reporting from people. So, the same method is used here in the update as for the earlier versions. The results are shown in table 9.

Table 9 Monetary values of environmental impacts from land use

Flow group	Flow unit	Natural capital loss, EUR/flow unit
Residential & commercial developments in cities		
Housing and urban areas on arable land	m2year	2.85E+01
Housing and urban areas on forestland	m2year	2.85E+01
Housing and urban areas on impediment	m2year	2.84E+01
Commercial & industrial areas on arable land	m2year	2.85E+01
Commercial & industrial areas on forestland	m2year	2.85E+01
Commercial & industrial areas on impediment	m2year	2.83E+01
Residential & commercial developments in towns		
Housing and urban areas, arable land	m2year	6.47E-01
Housing and urban areas, forestland	m2year	5.78E-01
Housing and urban areas, impediment	m2year	4.63E-01
Commercial & industrial areas, arable land	m2year	6.36E-01
Commercial & industrial areas, forestland	m2year	5.67E-01
Commercial & industrial areas, impediment	m2year	4.52E-01
Agriculture and Aquaculture		
Annual&perennial non-timber crops	m2year	9.21E-04
Wood & pulp plantations	m2year	1.48E-03
Livestock farming and ranching	m2year	2.09E-04
Marine and freshwater aquaculture	kg produced	1.24E-03
Energy production and mining		
Oil and gas drilling	kg produced	5.19E-05
Mining and quarrying	m2year	6.30E-01
Renewable energy	m2year	9.42E-04
Transportation and service corridors		
Roads and railroads	m2year	7.46E-01
Utility and service lines	m2year	1.48E-04
Biological resource use		
Logging and wood harvesting	m2year	2.87E-04

Radionuclides

Emissions to air

Table 10 shows natural capital loss from radionuclides emitted to air from ordinary operation of nuclear sites, i.e. excluding accidents.

Table 10 Monetary values of environmental impacts from emissions of radionuclides to air.

Flow group	Loss of natural capital, €/TBq
C-14	1.07E+07
H-3	1.51E+02
I-129	5.05E+05
Kr-85	2.52E+02
Pb-210	1.26E+05
Po-210	1.26E+05
Ra-226	7.57E+04
Rn-222	1.89E+03
Th-230	3.78E+06
U-234	1.01E+06
U-238	8.83E+05

Discussion

In comparing the estimates of loss of natural capital made for the 2020d and 2025d EPS versions, CO_2 and Au resources remain in the top, but some changes in the top ten emissions/resources are particularly obvious: oil from ground, coal from ground, NMVOC to air, PM2.5 and Cd from ground.

Oil from ground was ranked nr 10 in the 2020d version and as nr 3 in the 2025d version. The reason for the change is primarily due to an increased cost of replacement with a sustainable alternative. The replacement cost has increased partly because of increased demand and partly due to a matured market for HVO, motivating us to abandon the cheaper and more speculative replacement alternative based on the Fisher-Tropsch process with wood as an input. But if the replacement cost is dependent on demand, which demand level should be used? Replacing all crude oil with HVO diesel would not be possible, and the price for such a demand level very high, almost impossible to assess and unlikely to happen. Consequently, it seems reasonable to apply the present supply/demand-price. In terms of guidance in product development, it would perhaps give too low incentives in a longer perspective, but still meaningful. Like when turning the steering wheel as much as the sight of the road ahead allows.

The sustainable alternative to coal from ground, charcoal, has increased in median price from 0.258 to 0.366 €/kg, changing its rank in terms of global cost from 16 to 7. However, this change is within the estimated uncertainty (a factor of 2), which mainly is due to an unclear definition of "coal". The cost of charcoal is largely determined by its use for cooking, which requires much less quantities than present use of fossil coal. To decrease the uncertainty, one would probably have to determine separate values for different flow volumes. In a supply-demand context, costs vary with volume. For many emissions, like for toxic substances, there is a similar problem: impacts depend on volumes. But in LCA, this information is scarcely available, and it is more practical to account for it as an uncertainty. If this uncertainty is material for the decision at hand, a more sophisticated valuation may be motivated.

The damage cost of impacts from NMVOC has doubled. The reason is new and higher estimations of YLL from NMVOC-induced NOx, which are population weighted (Aditya Nalam et al. 2025). A similar increase in impact from anthropocentric NMVOC is assumed, when using the POCP values from literature.

The loss of natural capital value from Cd mining has increased. The main reason is the increased cost of the hydrometallurgical process.

The impact from urban land use from cities is ranked as nr 4. In the 2020 version, separate impacts from large cities >500000 inhabitants and medium sized cities < 500000 inhabitants were estimated, but LCA data for these categories were seldom available. In the 2025 version we adapt to the UN population statistics, where cities are one category. There, cities are urban areas with more than 50000 inhabitants.

Table 11 Comparison of estimations of loss of natural capital between the EPS version 2020d and 2025d.

		2020				2025			
Elementary flow	Unit	Natural capital loss	Global flow	Natural capital loss	Rank	Natural capital loss	Global flow	Natural capital loss	Rank
		€/unit	units	€		€/unit	units	€	
CO_2	kg	3.24E-01	3.26E+13	1.06E+13	1	2.72E-01	3.63E+13	9.87E+12	1
Au	kg	2.91E+06	2.60E+06	7.56E+12	3	2.60E+06	3.30E+06	8.59E+12	2
Oil	kg	7.27E-01	4.01E+12	2.91E+12	10	1.67E+00	4.61E+12	7.69E+12	3
Urban land use	m2yr	n.a.				2.85E+01	1.33E+11	3.79E+12	4
Cu	kg	1.31E+02	1.80E+10	2.36E+12	12	1.40E+02	2.30E+10	3.21E+12	5
PM2.5	kg	2.44E+02	3.80E+10	9.26E+12	2	7.97E+01	4.00E+10	3.19E+12	6
Coal	kg	2.58E-01	7.26E+12	1.87E+12	16	3.66E-01	8.70E+12	3.18E+12	7
NMVOC	kg	1.10E+01	1.269E+11	1.39E+12	21	1.95E+01	1.60E+11	3.11E+12	8
CH_4	kg	1.11E+01	3.33E+11	3.71E+12	7	7.70E+00	3.56E+11	2.74E+12	9
Cd	kg	5.35E+04	2.20E+07	1.18E+12	19	9.92E+04	2.40E+07	2.38E+12	10

It is striking that the differences in loss of natural capital between elementary flow groups are relatively small. The loss of natural capital from rank nr 10 is only a third of that for rank nr 1. This explains why there can be such significant changes in ranking between the EPS versions, with moderate changes in natural capitals. Maybe there is some kind of damping mechanism, but today we see no such explanation for the small differences.

The magnitude of the global loss of natural capital is an indication of the priority for improvement in data quality, but also for mitigation, like how to implement circular economy and electrification of transports. In those cases, values of emissions and fossil resources must be compared to values of metal resources. Future updates will be needed to increase the quality of such data and communicate what they represent.

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Conclusion

Updated monetary values for environmental goods and elementary flows have changed compared to the 2020 version due to changes in prices and cost and due to new knowledge on impact pathways. Uncertainty estimates have also changed due to new knowledge on impact pathways.

Future updates are recommended. The Excel file in the supplementary material will help with such updates.

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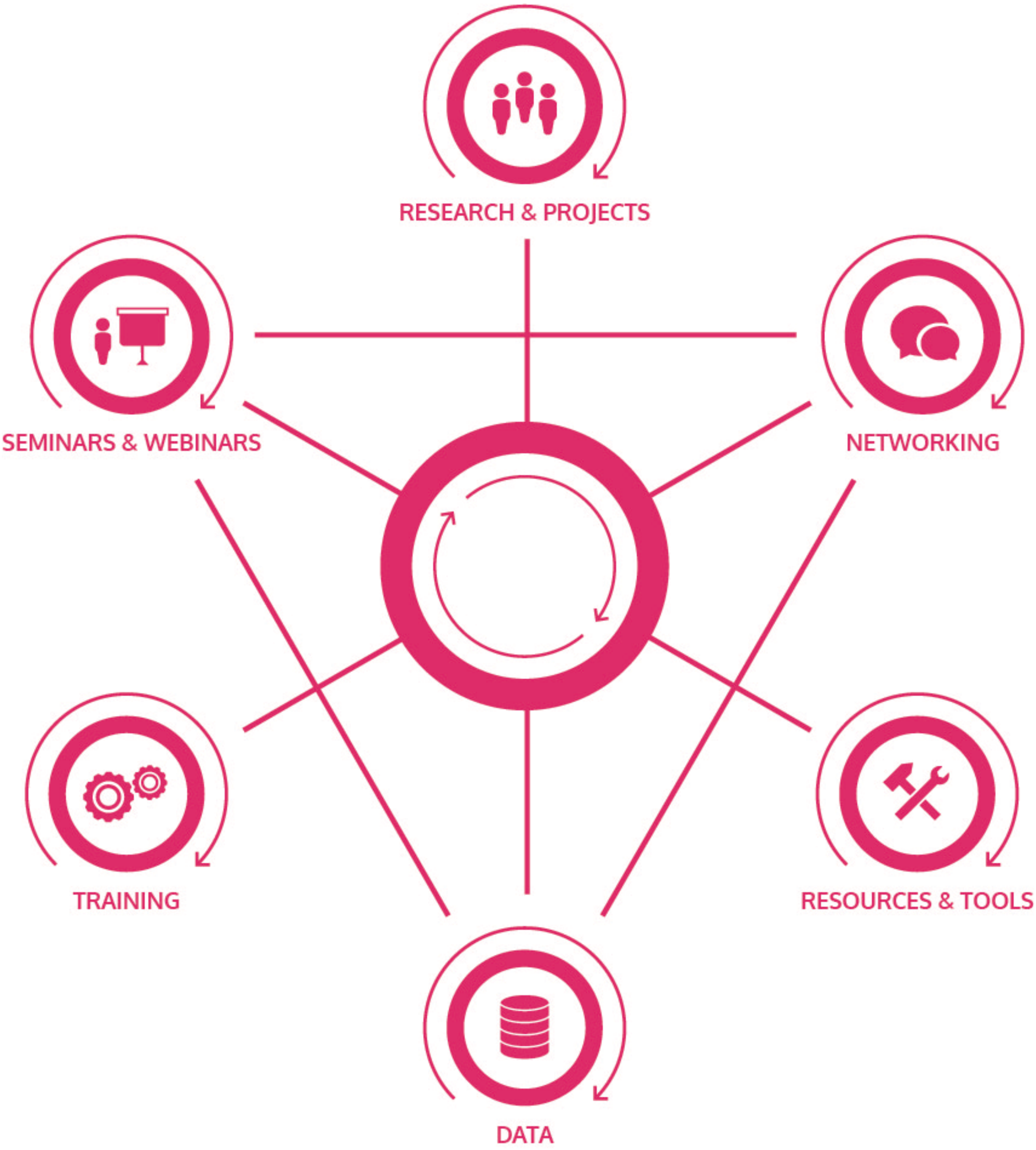

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