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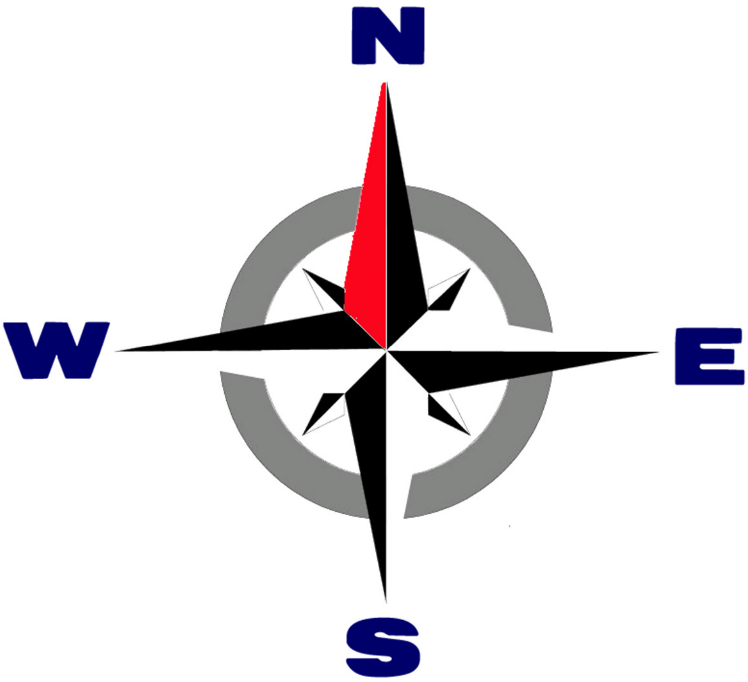

The EPS 2015d impact assessment method – an overview

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Introduction

This overview is intended to be read as a complement to the file *EPS 2105d.xls*, where quantitative impact assessments are made for the EPS 2015 default impact assessment method.

The EPS system was developed during the 1990s to assist designers and product developers in evaluating the environmental performance of design options. It was intended to work like a compass, to give fast indications of where the environmental impacts were lowest. The EPS system is a systematic approach to promoting environmental performance in normal product development, and includes a default impact assessment method. In the year 1999 the EPS system was described in two publications, one about the system (Steen 1999a) and one for the default impact assessment method (Steen 1999b). It is based on LCA methodology and follows the ISO 14040 and 14044 standards. EPS is an acronym for "Environmental Priority Strategies in product design".

The EPS system takes its start in the choices a product developer or a designer makes in normal work: Which material to use?, how to join components?, which surface treatment?, which fuel?, what lubricants?, which dimensions?, etc. In normal product development, environmental performance is just one of many performance criteria considered and the time for evaluating options is short. In an early phase, rules of thumb or single indicators are almost necessary, in later stages, more detailed analysis may be possible.
Besides being fast and easily determined an indicator has to be relevant. It should be able to tell (1) which alternative that has the least environmental impact, and (2) what is acceptable.

The EPS system

The EPS system has not been changed since 1999. It is characterized by a five system principles applied in a hierarchical order:

1. The top-down principle. Any choice of model, data or procedure is guided by its ability to contribute to improved environmental performance of the product in normal product development environments. This means that time and cost for an evaluation have to be weighed against the value of improved environmental performance of the product.

2. The index principle. The user of the EPS system shall be able to describe a product life cycle in terms of materials and processes for which ready-made weighted impacts assessments shall be available as indices. The indices shall represent separate weighted and aggregated environmental impacts of different types of materials with respect to production, processing and waste management.
3. The default principle. Default indices shall be available for quick analysis of any product design feature under consideration. Later, more specific data may be used.
4. The uncertainty principle. Uncertainty is a part of reality, and shall be a part of the analysis. Data shall be represented by a best estimate and an uncertainty measure. Sensitivity analyses shall be available to indicate the rigidness of a priority.
5. Choice of default indices. The actual choice of default indices are made, considering current knowledge and needs of the user. Choices are made both for inventory data and for impact assessment data. Inventory data need to be organized consistently with respect to allocation rules, so that they can be used in a modular way for production, processing and waste management of materials or components. Impact assessment data are organized to express monetary values of environmental impacts from emissions and use or resources. Default indices thus express monetary values of environmental impacts from production, processing and waste management of materials and components.

The structure of the EPS system, with its current version of default indices, is shown in figure 1. The designer has a price list with monetary values of environmental impacts from materials and processes, for instance for the manufacturing of polyethylene (PE) and various types of waste management. The designer makes calculation of the total environmental impact value of the product concept in the same ways as he/she makes an ordinary economic calculation of production costs or total lifetime costs. The price list is prepared for the designer by environmental experts having made (1) estimations of monetary values of environmental state indicators, (2) impact models to link changes in state indicators to emissions and (3) resource extractions and inventories to link emissions and resource flows to materials and processes.

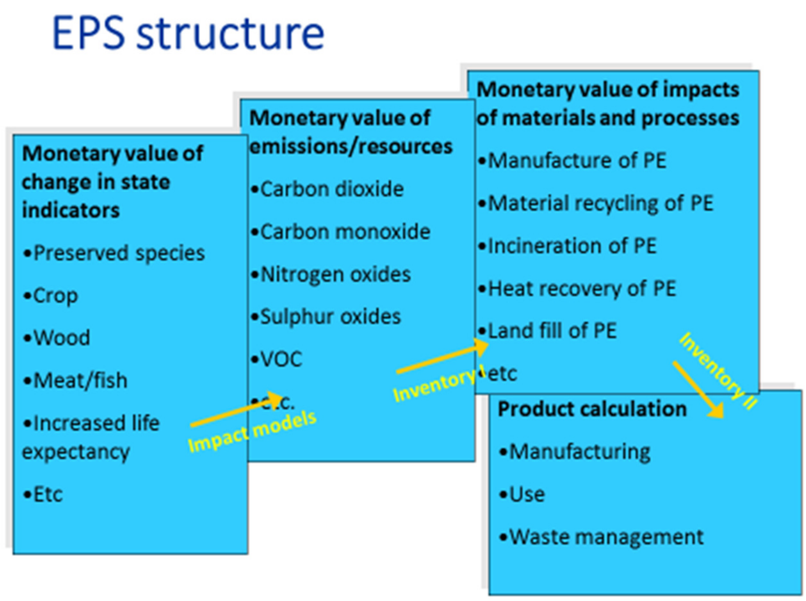

Figure 1. The structure of the EPS system

This report and its corresponding excel file *EPS 2015d* describe the two left sheets in figure 1, i.e. the monetary values of marginal changes in state indicators, impact models linking emissions and resource flows to changes in state indicators and monetary values of environmental impacts from emissions and resource flows.

Default impact assessment method

Choice of state indicators

Using current LCA terminology, impact indicators are chosen at the endpoint level. The term endpoint is considered somewhat misleading, as there hardly is any particular endpoint to an environmental intervention. "State indicators" are more in line with the UN terminology and are used here to represent assets in people's everyday life, which are subject to impacts from product systems.

In the beginning, environmental impacts were in focus for the EPS system, but since the first EPS version in the late 1980s, society's interest in impacts from product systems has shifted towards sustainability and to include both social and economic aspects. Therefore state indicators are also chosen for economic and social issues, and all indicators are selectedto represent assets contributing to sustainable development.

The definition of sustainable development given by the Brundtland commission is chosen. This means a focus on human well-being and poverty alleviation.

Choices of state indicators are made in a process starting from human basic needs, identifying satisfiers for needs, safeguard subjects to safeguard satisfiers from threats, and state indicators to describe the state of the safeguard subjects. The process and choices made are described by Steen and Palander (2015).

Table 1-3 show the state indicators chosen in the EPS 2015d version. Table 1 shows indicators that are monetary valued and impacted on by flows of product systems, i.e. emissions and use of resources. Table 2 shows indicators that are monetary valued and impacted on by the function(s) of product systems. Table 3 shows indicators that are quantitative but not monetary valued.

Impacts on state indicators in table 1 are subject to impact modelling in a traditional LCA way. Impacts on function related state indicators (table 2) are not modelled, but the monetary values may be used more or less directly, if there is a difference in functional performance between the alternative product systems that are being evaluated. Impacts on state indicators in table 3 are not modelled. If impacted on by alternative product systems, it may be possible to estimate an increase or decrease in the state indicator values.

Monetary values are selected as measures for the state indicators sustainability aspect for several reasons:

1. It is a common measure of well-being
2. It represents the core aim of any business: to create value
3. It is easily understood by any person
4. It is often used for trade-offs

There are many arguments against using monetary measures for sustainability indicators, such as: "the environment is not for sale", "you cannot use the same measure to solve a problem that created it" and "you can get any number, depending on how you valuate the environment".

So, monetary values need to be used with caution. In the EPS 2015d impact assessment method, monetary values have some special features:

1. The monetary measure aim at making the product developer aware of the significance of the sustainability impacts he or she creates with the product concepts in consideration. This is done by using values people like he or she (in our case, an average OECD inhabitant) would ascribe to the state indicators.
2. The values are expressed in ELU (Environmental load units), where 1 ELU is equal to 1 € under specific conditions.
3. 0% discounting of future impacts are made.

Table 1 Quantitative, monetary valued, flow related state indicators

Safe guard subject	State indicator type	State indicator	Indicator unit
Environmental			
Ecosystem services	Provisioning	Crop growth capacity	kg
Ecosystem services	Provisioning	Production capacity for fruit &	kg
Ecosystem services	Provisioning	Wood growth capacity	kg
Ecosystem services	Provisioning	Fish&meat production capacity	kg
Ecosystem services	Cultural	Quality time	personyears
Access to water	Water production capacity	Drinking water	kg
Access to water	Water production capacity	Irrigation water	kg
Abiotic resources	Depletion of oil reserves	Fossil oil	kg
Abiotic resources	Depletion of coal reserves	Fossil coal	kg
Abiotic resources	Depletion of natural gas reserves	Natural gas	kg
Abiotic resources	Depletion of Ag reserves	Silver ore	kg of element
Abiotic resources	Depletion of Al reserves	Aluminium-ore	kg of element
Abiotic resources	Depletion of As - Zr reserves	Element in mineral	kg of element
Biodiversity	Species extinction	NEX	dimensionless
Social			
Human health	Life expectancy	YOLL	personyears
Human health	Disability	Malnutrition	personyears
Human health	Disability	Diarrhoea	personyears
Human health	Disability	Malaria episodes	personyears
Human health	Disability	Migration	persons
Human health	Disability	Gravation of angina pectoris	personyears
Human health	Disability	Cardiovascular disease	personyears
Human health	Disability	Infarcts	personyears
Human health	Disability	Working capacity	personyears
Human health	Disability	Asthma cases	personyears
Human health	Disability	COPD severe	personyears
Human health	Disability	Cancer	personyears
Human health	Disability	Skin cancer	personyears
Human health	Disability	Low vision	personyears
Human health	Disability	Poisoning	personyears
Human health	Disability	Intellectual disability: mild	personyears
Human health	Disability	Osteoporosis	case
Human health	Disability	Renal dysfunction	case

Table 2 Quantitative, monetary valued, function related state indicators

Safe guard subject	State indicator	State indicator	Indicator unit
Economical			
Building technology	Capacity	Housing availability	m2
Building technology	Efficiency	Cost per living area and time	EURs/m2year
Energy technology	Capacity	Delivery capacity of electricity	kW
Energy technology	Efficiency	Cost perkWh	EUR/kWh
Environmental technology	Capacity	Drinking water devilery capacity	m3/day
Environmental technology	Efficiency	Cost per m3 water	EURs/m3
Food technology	Capacity	Delivery capacity	Mcal/day
Food technology	Efficiency	Cost per food unit	EUR/Mcal
Textile technology	Capacity	Delivery capacity	kg/year
Textile technology	Efficiency	Cost per unit clothing	EUR/kg
Information technology	Capacity	Volume stored	TB
Information technology	Efficiency	Cost per volume transferred	EUR/TB
Transport technology	Capacity	Goods delivery capacity	tonkm/year
Transport technology	Efficiency	Cost per mass and distance	EURs/tonkm
Transport technology	Capacity	Transport capacity for persons	personkm/year
Transport technology	Efficiency	Cost per person and distance	EUR/personkm
Income	Monetary	GNP/capita	EUR

Table 3 Quantitative, not monetary valued sate indicators

Safe guard subject	State indicator type	State indicator	Indicator unit
Social			
Continuity in relations		Separations	nr
Continuity in relations		Parental leave	pesonyears
Culture		Culture consumption	pesonyears
Culture, peace		Free press	nr
Culture, knowledge		Education	personyears
Jobs, occupation		Employment	personyears
Land availability		Population	nr of persons
Social security		Poverty	nr of persons
Social security, peace		Income equality	EUR or ratio

Choice of values of state indicators

The monetary values aim at market values. Where no real market values exist, different techniques are used to estimate the market values:

1. Ecosystem services
    a. Provisioning: Crop growth capacity, Production capacity for fruit & vegetables, Wood growth capacity, Fish&meat production capacity *Values measured as market values*
    b. Cultural: Quality time: *Value measured as market value*
2. Access to water
    a. Water production capacity: Drinking water, Irrigation water. *Values measured as restoration costs*

3. Abiotic resources:
    a. Depletion of reserves: Oil, Coal, Natural gas, Ag ore, Al ore, As ore *etc. Values measured as restoration costs*
4. Biodiversity: Normalised extinction of species (red list based risk) *Value measured as prevention costs*
5. Human health: DALY categories: *Values measured as loss of economic productivity*

Impact modelling

The models used to link emissions and resource use to state indictors are simple, linear ones. The extent of a change in an indicator, due to an emission or resource flow, is quantified and divided by the emission causing the change. We then get an average change in state indicator per emission or resource unit. Changes may occur along several pathways and on several state indicators. The added changes in each state indicator along different pathways are calculated to give indicator specific characterization factors. The added monetary value for all impacts on state indicators is calculated to be used with inventory data.

Calculations, references and models are described in the files *EPS 2015d including climate impacts from secondary particles.xls and EPS 2015d excluding climate impacts from secondary particles.xls*

The reasons for the two versions is the uncertain and very negative damage costs obtained with the models for NOx and some other inorganic particle forming gases into consideration. The two versions allow for sensitivity analyses with respect to this uncertainty.

References

Steen, B, (1999a) A Systematic Approach to Environmental Priority Strategies in In Product Development (EPS). Version 2000 – General System Characteristics. Chalmers University of Technology, Centre for Environmental Assessment of Products and material Systems (CPM) Report 1999:4, Gothenburg 1999.

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