CHALMERS

Documentation of environmental impact assessment, compatible with SPINE and ISO/TS 14048

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Preface to the second edition

Changes made to this second edition are based on experiences from practical use of the documentation format. The following major changes have been made:

The concept of Aspect
Impact assessment begins with introduction of a disturbance that causes changes to the environment. The disturbance often is a chemical substance emitted to a media, such as air, water or ground. But the original cause of a disturbance may also be identified as e.g. lack of emission reduction systems, lack of an environmental management system, the occurrence of a production stage that causes the emission, or the property of a product design which requires a specific production stage. An aspect addresses any such origin of a disturbance, which means that aspect basically is defined in the same way as environmental aspect in e.g. ISO 14001.

It is possible to define aspects separately, and to assign an environmental characterisation to any environmental aspect.

Documentation of methods are made consistent
Experience shows that there are no practical differences for how to document aspect selection principles, impact indication principles, characterisation methods, weighting methods and impact assessment methods. They are therefore structured similarly in this second edition.

Other introduced consistencies
Persons and addresses, numerical quantities, units, and properties of different kinds have been simplified by introducing general structures for these four information types.

1 Documentation of impact assessment

Documentation of impact assessment should be made in accordance with the structure described in the international standard ISO 14042 Environmental management – Life cycle assessment – Impact assessment.

The central concepts of life cycle impact assessment in ISO 14042 are:

- *Impact category and Category indicator*
  Describes potential problem areas, where environmental impact may be observed.
- *Classification*
  Assigns LCI results to impact categories or category indicators.
- *Characterisation*
  Gives quantitative measure of the environmental impact on the impact categories or category indicators from the LCI results.
- *Weighting (optional)*
  A quantitative measure of the relative importance between different impact categories or category indicators.

Each of these concepts should be documented individually, with a level of detail appropriate for reliability, review, and reusability.

Having information and documentation about the four concepts, they can be combined in a structured manner into a consistent full *Impact assessment.* Such full impact assessments are useful when more than one LCA should make use of the same environmental impact modelling.

In addition, to the concepts of ISO 14042, the concept of *Aspect* been introduced for the documentation of impact assessment. An aspect addresses any origin of an environmental disturbance, which means that aspect basically is defined in the same way as environmental aspect in e.g. ISO 14001. For life cycle impact assessment the aspects specify elementary flows. It is possible to define aspects separately, and to assign an environmental characterisation to any environmental aspect.

In the following an appropriate structuring of documentation will be presented, which has been tested both for documenting the most commonly used and accepted impact assessment methods (WWLCAW), and for applications such as simplified LCA (Erixon, 2001) and design for environment for manufacturing industry (Dewulf et al, 2001). The structuring has been developed as an addition to the SPINE data documentation format, to include the capability to generally handle information about environmental impact assessment (Carlson & Steen, 1998).

The following sections are structured in accordance with the four central concepts in ISO 14042, and specify in detail a documentation format for these concepts. Also, the overall concept Impact assessment is described, structuring the other four.

1.1 Documentation of specification of elementary flows i.e. Aspects

Impact assessment starts with a specified elementary flow, such as emissions of ammonia into air, freshwater, or deep sea. It is important that specification of elementary flows allows for distinction not only of the substance of the elementary

flow, but also of to which media the substance enters (or leaves to), as well as specification of significant properties of the substance and the media. Such properties are important for impact assessment to correctly describe the environmental consequences in areas differently sensitive to different substances, or to distinguish between different forms of the same substance.

In this documentation structure specification of elementary flows for impact assessment is named Aspects. An aspect is a specification of a potential elementary flow, i.e. a potential environmental load, for example, if 1 kg of ammonia is released to air. The specification of such a potential emission is an aspect. Aspects may be specified in different situations, such as when identifying significant environmental aspects for an environmental management system, or when deciding on which elementary flows to consider in a full life cycle assessment, or when tracking different sources for greenhouse gas emissions. For each of these three examples one may identify a common principle for the selection of aspects, here named the *Aspect selection principle.* From having one common principle, many different aspects may be selected and specified.

1.1.1 Documentation of Aspect selection principle

The following information should be documented for an Aspect selection principle:

1.1.1.1 Name

A name of the overall principle or policy applied when selecting a set of category indicators, e.g. willingness to pay, distance to target.

1.1.1.2 Version

If the principle or policy is updated the updated versions are given successive version numbers.

1.1.1.3 Registration authority

The organisation responsible for the documented aspect selection principle.

1.1.1.4 Date completed

Date when the principle was formulated

1.1.1.5 Principal method name

Aspect selection principles are often variants or subsets of a general principle. For clarification this general principle can be named.

1.1.1.6 Method description

A description or statement of the principle.

1.1.1.7 Literature reference

Text describing the reference to literature.

1.1.1.8 Methodological range

The aspect selection principle may have been defined within a specific application, such as within an industrial sector, a geographical area or a specific set of products. A description of the range for which the principle was defined will help future users to assess and understand the range for the applicability of the list of aspects. This description may be provided in only the field *Methodological range,* to provide

geographical, temporal, organisational, political etc. scope considered for the principle, or the temporal, demographical or other limitations may be provided in the fields below.

1.1.1.9 Valid time span; start date, end date, description
Temporal scope considered for the principle. There may be a temporal validity for the selected aspects.

1.1.1.10 Demographic range
Cultural, organisational, political etc. scope considered for the principle.

1.1.1.11 Other limitations
There may be other types of limitations of applicability of the aspect selection principle.

1.1.1.12 Juridical person role; Address, Role
See Section 1.7.1 Documentation of Juridical Person Role.

1.1.1.13 Notes
Additional information for the description of the principle.

1.1.1.14 Property; Property name, Value
See section 1.7.2 Documentation of Property.

1.1.2 Documentation of Aspect

1.1.2.1 Reference to Aspect selection principle
Reference to Name and Version in Aspect selection principle

1.1.2.2 Name
If appropriate, the aspect can be given a name.

1.1.2.3 Substance name
Reference to Name in a substance nomenclature.

1.1.2.4 Substance nomenclature
Reference to the substance nomenclature through which Substance name is defined.

1.1.2.5 Unit
See section 1.7.4 Documentation of Unit

1.1.2.6 Notes
Additional information for the aspect.

1.1.2.7 Property; Property name, Value
See section 1.7.2 Documentation of Property.

1.2 Documentation of Impact category and Category indicator
The choice of how to express or indicate environmental impact is subjective and depends on the viewpoint of an “observer”. This viewpoint may be expressed as a “principle”, the *Impact indication principle.* With an impact indication principle,

different *Impact categories* can be chosen, as well as different *Category indicators.* Within a specific impact indication principle there is a clear distinction between impact categories, which are names of classes of environmental impacts, and category indicators, which are names of quantifiable environmental impacts belonging to impact categories.

1.2.1 Documentation of Impact indication principle

The following information should be documented for an Impact indication principle:

1.2.1.1 Name

A name of the overall principle or policy applied when selecting a set of category indicators, e.g. willingness to pay, distance to target.

1.2.1.2 Version

If the principle or policy is updated the updated versions are given successive version numbers.

1.2.1.3 Registration authority

The organisation responsible for the documented impact indication principle.

1.2.1.4 Date completed

Date when the principle or policy was formulated.

1.2.1.5 Principal method name

Impact indication principles are often variants or subsets of a general principle. For clarification this general principle can be named.

1.2.1.6 Definition

A definition or statement of the principle or policy.

1.2.1.7 Literature reference

Text describing the reference to literature.

1.2.1.8 Methodological range

The impact indication principle may have been defined within a specific application, such as within an industrial sector, a geographical area or a specific set of products. A description of the range for which the principle was defined will help future users to assess and understand the range for the applicability of the list of impact categories and category indicators. This description may be provided in only the field *Methodological range*, to provide geographical, temporal, organisational, political etc. scope considered for the principle, or the temporal, demographical or other limitations may be provided in the fields below.

1.2.1.9 Valid time span; start date, end date, description

Temporal scope considered for the principle. There may be a temporal validity for the selected aspects.

1.2.1.10 Demographic range

Cultural, organisational, political etc. scope considered for the principle.

1.2.1.11 Other limitations
There may be other types of limitations of applicability of the impact indication principle.

1.2.1.12 Geographical area
If existing, a reference to a geographical information system, addressing the geographical area for the range of the principle described.

1.2.1.13 Area description
If not relevant with a reference to a geographical information system, the geographical area may be described with text.

1.2.1.14 Notes
Additional information for the description of the principle or policy.

1.2.1.15 Juridical person role; Address, Role
See Section 1.7.1 Documentation of Juridical Person Role.

1.2.1.16 Property; Property name, Value
See section 1.7.2 Documentation of Property.

1.2.2 Documentation of Impact category
The following information should be documented for an Impact category:

1.2.2.1 Name
The name of the impact category.

1.2.2.2 Description
A description of the impact category.

1.2.2.3 Category indicator
A reference to the category indicators that have been selected for the Impact category.

1.2.2.4 Reference to Impact indication principle
Impact categories must not be described without a clear reference to its Impact indication principle, since most of the definition of the impact category should be derived from the documentation of the Impact indication principle.

1.2.2.5 Notes
Additional information on the impact category.

1.2.3 Documentation of Category indicator
The following information should be documented for a Category indicator:

1.2.3.1 Name
The name of the category indicator.

1.2.3.2 Description
A description of the category indicator.

1.2.3.3 Default unit
The unit in which the category indicator is measured.

1.2.3.4 Impact category
A reference to the Impact category to which the category indicator belongs.

1.2.3.5 Reference to Impact indication principle
Category indicators must not be described without a clear reference to its Impact indication principle, since most of the definition of the impact category should be derived from the documentation of the Impact indication principle.

1.2.3.6 Notes
Additional information on the category indicator.

1.2.3.7 Property; Property name, Value
See section 1.7.2 Documentation of Property.

1.3 Documentation of Classification
Classification assigns LCI results to impact categories or category indicators, which means that the LCI practitioner makes a number of implicit choices. The results of these choices are explicitly documented simultaneously with the documentation of the characterisation, see the documentation of Characterisation below.

1.4 Documentation of Characterisation
Characterisation gives quantitative measure of the environmental impact on the impact categories or category indicators from the LCI results. The LCI results are in the form of a list of inputs and outputs. Depending on level of detail of the modelling of the environmental impact, different information about the inputs and outputs is needed, e.g. name of substance, amount, environmental conditions and geographical locations. Also, the environmental impact model needs to be described, in terms of a *Characterisation method,* which assigns the environmental consequences of an input or output to a category indicator and the *Characterisation parameter*, which together enables a mathematical expression of the characterisation factor.

1.4.1 Documentation of Characterisation method
The Characterisation method is the model that relates an input or an output of an LCI result with a quantification of its environmental impact on a category indicator.

The following information should be documented for the Characterisation method:

1.4.1.1 Name
A name of the characterisation method.

1.4.1.2 Version
If the method is updated, the updated versions are given successive version numbers.

1.4.1.3 Registration authority
The organisation responsible for the documented characterisation method

1.4.1.4 Date completed
The date when the method was finalised or published.

1.4.1.5 Principal method name
Characterisation methods often are variants of principal methods. For clarification the principal method can be named.

1.4.1.6 Method description
A description of the method.

1.4.1.7 Literature reference
A reference to literature where a detailed description of the method may be found.

1.4.1.8 Methodological range
The characterisation method may have been defined within a specific application, such as for a specific set of substances, within a specific geographical area or for a specific geographical or other resolution. A description of the range for which the characterisation method was defined will help future users to assess and understand the range for the applicability. This description may be provided in only the field *Methodological range*, to provide geographical, temporal, organisational, political etc. scope considered for the method, or the temporal, demographical or other limitations may be provided in the fields below.

1.4.1.9 Valid time span; start date, end date, description
Temporal scope considered for the characterisation method.

1.4.1.10 Demographic range
Cultural, organisational, political etc. scope considered for the method.

1.4.1.11 Other limitations
There may be other types of limitations of applicability of the method.

1.4.1.12 Geographical area
If existing, a reference to a geographical information system, addressing the geographical area for the range of the method described.

1.4.1.13 Area description
If not relevant with a reference to a geographical information system, the geographical area may be described with text.

1.4.1.14 Mathematical expression
Syntactic description of the mathematical rule to apply to the characterisation parameter types and parameters, if more than one parameter type is defined.

1.4.1.15 Notes
Additional information on the characterisation method.

1.4.1.16 Juridical person role; Address, Role
See Section 1.7.1 Documentation of Juridical Person Role.

1.4.2 Documentation of Characterisation parameter

The Characterisation parameter is the relation between an input or an output of an LCI result and a category indicator, expressed as the characterisation factor. (For the documentation format referenced, it is possible to document un-linear relationships between input and outputs and category indicators, but this has been omitted from this specific description.)

The following information should be documented for the Characterisation parameter:

1.4.2.1 Name

A name of the characterisation parameter.

1.4.2.2 Reference to Aspect

Reference to the Name of the Aspect and to the Name of the corresponding Aspect selection principle, for which the characterisation factor is valid.

1.4.2.3 Reference to Characterisation method

Reference to the characterisation method to which the characterisation factor belongs.

1.4.2.4 Reference to Category indicator

Reference to the Name of the environmental Category indicator and to the Name of the corresponding Impact indication principle, for which the characterisation factor is valid.

1.4.2.5 Amount

The quantitative value of the characterisation parameter (see section 1.7.3 Documentation of Amount). The explicit specification of the unit of the Category indicator and the unit of the Aspect are referenced in Aspect and Category indicator respectively.

1.4.2.6 Notes

Additional information on the characterisation parameter.

1.5 Documentation of Weighting

Weighting is a quantitative measure of the relative importance between different impact categories or category indicators. There are different *Weighting methods* to compile and calculate these relative weights, and each different method results in different sets of relative *Weighting factors*.

1.5.1 Documentation of Weighting method

The following information should be documented for the Weighting method:

1.5.1.1 Name

Name of the weighting method.

1.5.1.2 Version

If the weighting method is updated, the updated versions are given successive version numbers.

1.5.1.3 Registration authority
The organisation responsible for the documented weighting method

1.5.1.4 Date completed
The date when the method was finalised or published.

1.5.1.5 Principal method name
Different weighting methods generally are based on more general methods, e.g. willingness to pay, distance to target.

1.5.1.6 Method description
A description of the method.

1.5.1.7 Literature reference
A reference to literature where the method is described in detail.

1.5.1.8 Methodological range
The weighting method may have been defined within a specific application, such as for a specific organisational or political domain, within a specific geographical area or for a specific temporal or other resolution. A description of the range for which the weighting method was defined will help future users to assess and understand the range for the applicability. This description may be provided in only the field *Methodological range*, to provide geographical, temporal, organisational, political etc. scope considered for the method, or the temporal, demographical or other limitations may be provided in the fields below.

1.5.1.9 Valid time span; start date, end date, description
Temporal scope considered for the weighting method.

1.5.1.10 Demographic range
Cultural, organisational, political etc. scope considered for the method.

1.5.1.11 Other limitations
There may be other types of limitations of applicability of the method.

1.5.1.12 Geographical area
I existing, a reference to a geographical information system, addressing the geographical area for the range of the method described.

1.5.1.13 Area description
If not relevant with a reference to a geographical information system, the geographical area may be described with text.

1.5.1.14 Notes
Additional information on the weighting method.

1.5.1.15 Juridical person role; Address, Role
See Section 1.7.1 Documentation of Juridical Person Role.

1.5.2 Documentation of Weighting factor

A weighting method is associated with a set of category indicators. Each indicator is associated with a weighting factor, expressing this indicators relative weight to the other indicators in that set.

The following information should be documented for the Weighting factor:

1.5.2.1 Reference to the Category indicator.

Reference to the Name of the environmental Category indicator, for which the weighting factor is valid.

1.5.2.2 Reference to Weighting method.

Reference to the weighting method to which the weighting factor belongs.

1.5.2.3 Amount and Unit of weighting measure

The numerical value of the weighting factor (See section 1.7.3 Documentation of Amount), together with an explicit specification of the unit of the weighting measure for which the factor is calculated. The unit of the category indicator is referenced in Category indicator.

1.5.2.4 Notes

Additional information on the weighting factor.

1.6 Documentation of full Impact assessment

Full Impact assessment includes all four separate concepts described above, in a logical sequential order, and a definition of the scope of the intended application of the impact assessment. The scope typically encompasses several complementary category indicators, a geographical area, and a consideration of many different stakeholders. When creating an impact assessment, one therefore is guided by an environmental policy to select a set of suitable category indicators and to prioritise between those category indicators in different trade-off situations. One must also have a clear opinion about the natural environment included in the scope, and it is necessary also to have a clear opinion about which inputs and outputs that are implied by the scope.

The documentation of a full impact assessment is done in two steps, first the *Impact assessment method* is documented, describing the general prerequisites for the impact assessment, and then all *Impact assessment selections* is documented as lists of references to category indicators, characterisation parameters and weighting factors.

1.6.1 Documentation of Impact assessment method

The Impact assessment method describes how impact indication principles, weighting methods, and characterisation methods has been selected and combined.

The following information should be documented for the Impact assessment method:

1.6.1.1 Name

A name for the impact assessment method

1.6.1.2 Version
If the method is updated, the updated versions are given successive version numbers.

1.6.1.3 Registration authority
The organisation responsible for the documented impact assessment method

1.6.1.4 Date completed
Date when the method was finally published.

1.6.1.5 Principal method name
Name of the principal method applied for the work.

1.6.1.6 Method description
Description of the impact assessment method.

1.6.1.7 Literature reference
Reference to literature where a full description of the method can be found.

1.6.1.8 Methodological range
The impact assessment method may have been defined within a specific application, such as for a specific range of impact assessments, within a specific industrial sector, for a range of product types, or to implement a specific policy, or for some geographical, ecological or demographic resolution. A description of the range for which the impact assessment method was defined will help future users to assess and understand the range for the applicability. This description may be provided in only the field *Methodological range*, to provide geographical, temporal, organisational, political etc. scope considered for the method, or the temporal, demographical or other limitations may be provided in the fields below.

1.6.1.9 Valid time span; start date, end date, description
Temporal scope considered for the impact assessment method.

1.6.1.10 Demographic range
Cultural, organisational, political etc. scope considered for the method.

1.6.1.11 Other limitations
There may be other types of limitations of applicability of the method.

1.6.1.12 Geographical area
If existing, a reference to a geographical information system, addressing the geographical area for the range of the method described.

1.6.1.13 Area description
If not relevant with a reference to a geographical information system, the geographical area may be described with text.

1.6.1.14 Notes
Additional notes on the impact assessment method.

1.6.1.15 Juridical person role; Address, Role
See Section 1.7.1 Documentation of Juridical Person Role.

1.6.2 Documentation of Impact assessment selections
Having documented the impact assessment method, the rest of the documentation of impact assessment can be reduced to documenting the selection of the category indicators, the inputs and outputs, the characterisation parameters, and the weighting factors.

It is in practice important to keep in mind that the selection of weighting factors should reference exactly the same category indicators as the selection of the characterisation parameters.

The following information should be documented for the Impact assessment selections:

1.6.2.1 Reference to impact assessment method
Reference to the impact assessment method to which the impact assessment selection belongs.

1.6.2.2 Selection of Category indicators
A list of references to the selected category indicators. (This selection is implied by the selection of characterisation parameters, since a characterisation parameter references precisely one category indicator.)

1.6.2.3 Selection of Aspects
A list of references to the selected aspects for which the impact assessment is valid. (This selection is implied by the selection of characterisation parameters, since a characterisation parameter references precisely one input and output.)

1.6.2.4 Selection of Characterisation parameters
A list of references to the selected characterisation parameters.

1.6.2.5 Selection of Weighting factors
A list of references to the selected weighting factors.

1.7 General documentation structures

1.7.1 Documentation of Juridical person role
The documentation structure allows for identification of involved persons and organizations and their role in relation to the documented information. This is documented as follows:

1.7.1.1 Address
The address to the involved person or organization, including name, mail address, electronic addresses and other relevant contact information.

1.7.1.2 Role

The role that the person or organization have in relation to the documented information, such as commissioner, practitioner, reviewer, generator etc.

1.7.2 Documentation of Property

The documentation structure is flexible and allows for defining new properties of concepts without changing the documentation structure. New properties are general described by the following terms:

1.7.2.1 Property name

A flexibly defined new property is identified by its given name. Examples are:

- boiling temperature (property of a substance)
- significant environmental aspects (property of an aspect selection principle)
- design priorities (property of a weighting method)

1.7.2.2 Value

The value of a property may be, using the above given examples:

- 97 degrees Celcius (value of boiling temperature)
- Plant A Q3 2005 (value of significant environmental aspects)
- Design project X (value of design priorities)

1.7.3 Documentation of Amount

An amount can be documented in terms of statistical properties, i.e. the name of the distribution function, names of parameters of the distribution function and quantitative values on each parameter and the unit of the amount. Thus, an amount is expressed by a *name,* and one or several *parameters* together with a *unit*.

1.7.3.1 Name

Name of the distribution function that is used to describe the amount. The name may be specified by a nomenclature. Examples of names are Non-statistical single, Non-statistical range, Non-statistical distribution, and Normal distribution. Non-statistical refers to that the amount is not statistically acquired and treated.

1.7.3.2 Parameter

One or several parameters for the amount, where the actual value are specified. The set of parameters are specified by the distribution function.

Each parameter is expressed in terms of a *Name* and a *Value*

- *Name* The name of the parameter, e.g. Quantity, QuantityMin, QuantityMax. The name may be specified by a nomenclature.
- *Value* The value of the parameter. Please note that the unit for the parameters are supplied in *Unit* (below).

For the distribution functions mentioned above, the following parameters should be used:

Name of distribution function	*Parameter – Name*
Non-statistical single	Quantity

Non-statistical range	QuantityMin QuantityMax
Non-statistical distribution	Quantity QuantityMin QuantityMax
Normal distribution	Expectation Standard deviation

1.7.4 Documentation of Unit

A unit is documented by:

- *Unit* The unit or symbol for an amount. SI-units are recommended.
- *Unit explanation* Explanation and/or reference of the symbol or name. When SI-units are not used, it is important that the unit or symbol is explained, in order for it to be correctly interpreted.

2 Examples of documentation of impact assessment

The following examples are documented by Baoren Wei, at Chalmers, when using the software tool WWLCAW, both to test the documentation principles and format, and to test the most commonly used impact assessment methods, EDIP (Wenzel et al 1997), EPS 2000 (Steen 1999) and Eco-Indicator 1999 (Goodkoop & Spriensma 2000). To keep the examples consistent, they are only taken from EPS 2000, which is originally compiled by Bengt Steen at Chalmers. The full documentation of all three methods can be viewed in WWLCAW.

Note: the examples were developed based on the first edition of this report, but are still valid for this second edition.

2.1 Documentation of Impact category and Category indicator

2.1.1 Documentation of Impact indication principle

2.1.1.1 Name

EPS

2.1.1.2 Version

2000

2.1.1.3 Definition

Introduction

The need for a better environment is generally accepted in society and numerous activities have evolved with the intention of promoting a sustainable development. The 'Agenda 21' -influenced activities of governments and authorities and the environmental management activities of companies, standardised in the ISO-14000-series, demonstrates this. Looking back at what has been done so far of the intentions expressed at the Rio conference, you find that there has been an intensive development of management systems.

The tool described here, the EPS system, (EPS stands for Environmental Priority Strategies in product design) was developed to meet the requirements of an everyday product development process, where the environmental concern is just one among several others. The development of the EPS system was started during 1989 on a request from Volvo and as a co-operation between Volvo, the Swedish Environmental Research Institute (IVL) and the Swedish Federation of Industries. Since then it has been modified several times during projects, which have involvied several companies, like in the Swedish Product Ecology Project (Ryding et. al 1995) and the Nordic NEP project (Steen et.al, 1996). The last modification is made within the Centre for Environmental Assessment of Products and Material Systems, CPM http://www.cpm.chalmers.se).

Goal

- *To be operative in a normal product-developing environment and to be able to assess which of two (or more) concepts that has the least impact on the environment.*
  This means that the system must quickly be able to give recommendations in the early phases of the product development on the basis of general information. During later phases it shall allow more elaborate and precise recommendations and investigations as more detailed and specific information on the concepts become available. The demand about the system being operative contains a demand on usefulness and cost effectiveness. The extra efforts the designer makes are to result in a reasonable improvement for the environment and the product.

- *To assess the added value from all types of impacts.*
  This requirement is partly a consequence of the demand on the system to be operative. It is considered unrealistic to take for granted that a product developer, who already has many technical and economical considerations to make, would be able to handle several different impact numbers. He or she ought to have the possibility of choosing the degree of complexity and detail in the information.

- *To communicate an understanding of the magnitude of the impact.*
  The result of the EPS analysis should be possible to be weighed against other demands on the product. To offer a forum for growth of a product related environmental strategy within a company in terms of “the 4 p’s”: plan, pattern, position and perspective. A plan is the original meaning of a strategy. A pattern means that it is not all decided from the beginning. A strategy grows as a pattern from various actions taken develops and many actors contribute. Position means that a company’s environmental activities are profiled in relation to its market and competitors. Perspective means that it offers a way of learning.

Scope

The EPS system is mainly aimed to be a tool for a company’s internal product development process. It may be used externally and for other purposes, like for environmental declarations, for purchasing decisions, for education or for environmental accounting, but in those cases, the knowledge of the EPS system and its features and limitations is crucial.

The justification of many of the models used in impact assessments and for estimating inventory data relies on the fact that we analyse product systems. Such systems generally contain many emission or resource depletion events in various places, and we can get a fairly good estimate of the added impacts despite not knowing the individual impacts.

Like for an aeroplane, the added weight of its next unknown 200 passengers may be estimated with higher relative precision than the weight of its next unknown passenger. The models used may therefore not be applicable in other contexts. In particular, care should be taken when using the default models and data given in this work for specific impact assessment cases, like single plants or events. The EPS system is a strategic tool. Like all LCA's its impact assessment is made in relation to a functional unit. This means that there is no possibility of detecting a violation of an emission or a media quality standard. This has to be done with other methods.

Environmental philosophy

In the development of the EPS system, it was decided to choose a default evaluation of environmental impacts which as much as possible was compatible with the goals set by the earth summit at Rio.

The Rio conference is to a large extent evaluating the environmental impact in terms of its relation to a "sustainable development". This means that the interest of resources increase compared the focus of earlier environmental concern: effects of emissions. The Rio conference deal with resource aspects not only in terms of natural resources but also in terms of society's ability to respond to environmental threats.

It has not been possible to find a measure of society's ability to adjust to environmental threats and in particular to determine how this is influenced by a product concept. Therefore this particular aspect is left out of consideration in the EPS system. The Rio protocol was not the result of an isolated event. It was to a large extent reflecting the current attitudes on environmental issues, let be of overnement 'environmentalists'. The issues brought up in Rio were issues that had been under discussion for many years, issues that you may find in most comprehensive literature on environment and in national environmental goals.

At the Swedish Environmental Protection Agency, environmental issues are described as 'threats' and 'safeguard subjects'. Threats are mechanisms, like acidification and global warming. Safeguard subjects are the things we want to safeguard in the environment, like human health and bio-diversity.

The EPS default method evaluates impact on the environment via its impact on one or several safeguard subjects. These have been chosen from those that were included in the Rio protocol, although not necessarily explicitly formulated there: human health, resources, ecosystem production capacity, bio-diversity and esthetical values. Today the safe guard subject 'esthetical values' is extended and named 'cultural and recreational' values and resources are specified as 'abiotic stock resources'. You may argue that bio-diversity and ecosystem production capacities are resources or that everything is of interest because it sooner or later impacts on human health. But if you do not know how certain threats will develop, uncertainty may call for a separate

guard. Now, if the default environmental goal used in the EPS system is chosen to be the preservation of the safeguard subjects, a reference state has to be chosen and a way of weighing deviations from the reference state. In line with the goal to produce an understandable answer and to have as few rules as possible, the simplest solution to the reference problem is to chose the current state of the safeguard subjects, and only look for changes in the safeguard subjects. The present state ought to the one that is easiest to describe. Besides, in practical use of LCA tools we can hardly ever use anything else than linear relationships. Under those circumstances, the choice of reference state will not influence the result, at least not in an analysis of incremental environmental changes caused by human activities.

How do we then weight various changes in the safeguard subjects towards each other? In the goals and superior principles given above there are some requirements that influence the choice of weighting principle. First we have the demand on an understandable measure. Second we have an orientation towards sustainability in our environmental philosophy. Sustainability has very much to do with resources and reserves. On a long-term basis it is more or less impossible to foresee all problems that will occur. A good strategy is to keep resources to be able to solve the problems. Therefore a monetary approach is chosen.

An interesting parallel may be found in psychotherapeutic strategy. If increasing the mental capacity of the patients, they are able to solve the various problems they might face to the best (Pedersen, 1986). This strategy may be compared to the traditional treatment of physicians: to eliminate the problem at hand. Lohman (1969) concludes that in health care, problem elimination is a dominating activity. He explains this with the enormous impact Pasteur and his successors have had on the society and on disciplines outside their own. Pasteur showed that it was possible to find the evil and cure it. In environmental strategies the ‘problem eliminating strategy’ is dominating and has been for long. Among LCA experts there is a common way of expressing the environmental goal as "less is better" If there are no emissions or resources used, the environment will be OK.

Looking at some distance at these two strategies, it seems reasonable that the problem eliminating strategy is applied in acute situations and in a short time perspective. For longer planning, a more resource-oriented approach is to prefer.

A resource oriented, widely understood measure is the monetary measure. However this can be expressed in several ways. In the EPS system a kind of ‘willingness to pay’(WTP) to restore changes in the safe guard subjects have been chosen as the monetary measure. The WTP is measured in today’s OECD population and applied to all those, who are affected by a change. No discounting for future effects are made as future generations have the same right to a good environment as we have (Rio Convention). The basic values of the environment are not considered subject to change. The OECD values of today are used even for impacts on people outside OECD and for future generations. This way of looking at the impacts may be called anthropocentric altruism. Willingness to pay is understood as an expression of an attitude in monetary terms towards a change regardless of whom is guilty to the change. The reason for using the OECD values of today for other populations are mainly two: 1) it is practical in that it is measurable, 2) it is mostly the OECD inhabitant of today that are making the decisions as designers. An alternative had been

to choose the restoration cost, or willingness to accept (WTA). Restoration cost would have given some unrealistic results, since we often chose to live with environmental degradation or positive changes rather than restoring them at unreasonable high cost. Bad odour is one example, noise is another, meadows created by grazing cattle's a third. WTA is more difficult to measure than WTP but given the modifications of WTP expressed above the difference decrease. WTA also has the problem of claims for compensation that are much higher than the available money. This problem is big enough with the WTP approach as it does not 'cost' anything to express a high WTP. To some degree, the technique of determining WTP can decrease this problem, but not fully. Some results, like results from CVM (Contingent Valuation Method) studies, are not directly additive in a strict economic sense. If one wants to use CVM-based WTP:s together with WTP determined by other methods, for instance hedonic pricing, one has to 'translate' the levels. Many environmental economists use various discount rates (ExternE, 1995). However,even at very low discount rates effects lasting for hundreds of years may be overlooked. For instance the greenhouse effect tend to be more or less negligible in some studies (Azar,1996).The WTP as used in the EPS default weighting method is separate from the WTP used in many cost-benefit studies in that is does not include direct impacts on the economy. For instance, a loss of income due to hospitalisation which is included in the ExternE study (1995) is not included in the EPS default weighting method, as the economic system is not included in the safeguard subjects.

The values of the WTP will change from person to person and from generation to generation. This is not a deficiency, it is simply a part of reality. Different experiences and life situations most likely will result in different attitudes to changes in the environment. For future generations we would ideally like to include their attitudes. But it is very difficult to understand what another person will think about changes in their life conditions. The most common way of approaching this problem is the one we teach our children. We would ask them: what would you think if this happened to you? The WTP as it is used here is not an ultimate WTP. For instance, if there was very little food available, the WTP for crop would probably be as much as there was money available. The WTP, which is chosen in the EPS default method, relates to everyday life conditions. Normally you are not willing to pay more than it takes. There is an easy way a designer can understand the default indices and the results of an calculation with the indices. They represent the money he or she together with other OECD inhabitants would be willing to pay, to avoid the impacts from the design he/she considers. Another way of looking at the indices and the impact values is as representing an average risk. Risk is normally understood as a probability of an event times a consequence. The indices express the most probable change in the environment times its consequence in terms of WTP

2.1.1.4 Date completed
1999

2.1.1.5 Methodological range
This system is for LCA. Time scale is 1990s and geographical range is Europe. WTP (willingness to pay) is for industry country

2.1.1.6 Geographical area

2.1.1.7 Notes

Ryding, S-O, ed., “Miljöanpassad produktutveckling” Industrilitteratur, Stockholm, 1995

Steen, B., “EPS-Default Valuation of Environmental Impacts from Emission and Use of Resources, Version 1996”, Swedish Environmental Protection Agency, AFR Report 111, April 1996.

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Azar, C. and Sterner, T. (1996). Discounting and distributional Considerations in the context of Global Warming, Ecological Economics 19, 169-185.

2.1.2 Documentation of Impact category

2.1.2.1 Name

Indicators for production capacity of ecosystem

2.1.2.2 Description

Indicators for production capacity of ecosystem

Decreased yields of crop, fish&meat, wood and freshwater are end point effects associated with production capacity of ecosystems. Different types of crops are grouped together as they may be exchangeable as a source of carbohydrates. Different types of fish&meat may be exchangeable as a protein source. Different types of wood may be exchanged in most applications in a modern society. The indicator chosen for these impact categories is a decreased production capacity of 1 kg. The weight refers to harvest weight for crop and fish&meat, while the dry substance weight is used for wood.

Choosing dry weight basis for all three had given the most accurate measure, but normally dry weights are not available for crops or fish&meat while the forest ndustry often monitors the humidity of the wood it is buying.

2.1.2.3 Category indicator

The default impact categories and category indicators are:

- Crop production capacity (Crop)
- Wood production capacity (Wood)
- Fish&meat production capacity (Fish&meat)
- Base cat-ion capacity
- Production capacity of irrigation water (Irrigation water)
- Production capacity of drinking water (Drinking water)

2.1.2.4 Reference to Impact indication principle

EPS

2.1.2.5 Notes

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2.1.3 Documentation of Category indicator

2.1.3.1 Name
Crop

2.1.3.2 Description
Crop production capacity measured as weight at harvest. Crops include all sorts of crops, like oat, wheat, barley, rice and corn. Different types of crops are grouped together as they may be exchangeable as a source of carbohydrates.

2.1.3.3 Default unit
Kg

2.1.3.4 Impact category
Indicators for production capacity of ecosystem

2.1.3.5 Reference to Impact indication principle
EPS 2000

2.1.3.6 Notes
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2.2 Documentation of Classification
See Documentation of Characterisation.

2.3 Documentation of Characterisation

2.3.1 Documentation of Characterisation method

2.3.1.1 Name
CO2 impact on crop

2.3.1.2 Version
1999

2.3.1.3 Date completed
1999

2.3.1.4 Principal method name
EPS: Global warming

2.3.1.5 Method description
Model

The characterisation factor is determined by an empirical method.

As mentioned in YOLL of EPS for CO2 the decrease in wheat production may be in the order of 5%. Today the global crop production (including wheat, rye, barley, oats, corn, rice, sorghum and potatoes) is 2.4 billion tons. If a 5% decrease is assumed for all crop types by the year 2090 the decrease will be 0.12 billion tons per year. An average over the 100- year period is assumed to be 60 million tonnes per year.

The characterisation factor is thus:

60×E+11*1.26×E–16 = 7.56E–4 kg crop/kg CO2

2.3.1.6 Literature reference
Parry, Martin. International climate conference at Maastricht, dec 8, 1994, (1994)

2.3.1.7 Methodological range
The impact is of global character. The modelled system is therefore global. The temporal system borders are 100 years (1990-2090). The society affected is the one described in IPCC scenario IS92A. (IPCC, 1990).

2.3.1.8 Geographical area
-

2.3.1.9 Mathematical expression
-

2.3.1.10 Notes
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2.3.2 Documentation of Characterisation parameter

2.3.2.1 Reference to input or output
CO2 emission to air

2.3.2.2 Reference to Characterisation method
CO2 impact on crop

2.3.2.3 Reference to Category indicator
Crop

2.3.2.4 Amount, Category indicator unit, Unit of input and output
7.56E-4 kg/kg

2.3.2.5 Notes
Global warming

2.4 Documentation of Weighting

2.4.1 Documentation of Weighting method

2.4.1.1 Name
EPS

2.4.1.2 Version
2000

2.4.1.3 Principal method name
Monetarization (Willingness to pay - WTP)

2.4.1.4 Method description

The term 'weighting' came to substitute the term 'valuation' during the development of ISO 14042. A major reason for that was to find a broader consensus in a term that did not emphasise the subjective element in this LCA step. There are many methods that allow comparison across impact categories, where the subjective element is limited to the choice of the weighting principle, like for instance the MIPS-measure (Schmidt-Bleek, 1994) where the total mass flow is used as an overall measure.

However in the EPS default method, the weighting is still made through valuation.

Although not explicitly expressed in ISO 14042, weighting requires definition of weighting indicators and weighting factors in a similar way as for characterisation of emissions. For the EPS default method there is only one weighting indicator, as only one value for the total environmental impact is requested.

1 Definition of default weighting indicator

The default-weighting indicator, which is preferred, is the willingness to pay (WTP) to restore impacts on the safeguard subjects, as measured amongst today's OECD inhabitants. The choice of today's OECD inhabitants is made in order to facilitate the understanding by the designer, who most likely is an OECD inhabitant or a person outside OECD with good contact with the OECD world. Today the OECD countries have a dominating role in the development of new technique and are beginning to adopt the ideas of sustainable development. Of course there are many other cultures that can claim to be more sustainable than those of the modern OECD countries, but their limited use of tools like LCA makes it more reasonable to investigate the consequences of their attitudes as options and not as a default.

The choice of default reference state is the environment of today. The reasons are similar as for the choice of WTP. There is a need for an understanding of what the reference state look like. Today's situation is real to us and can easier be communicated than a hypothetical state like 'the untouched nature’.

2 Methods to determine default weighting factors.

Weighting factors are the ratio of weighting indicators and impact category indicators.

They represent the WTP for one indicator unit. They are separately modelled and a set of models (factors) is used 'ready-made' by the LCA practitioner.

WTP for category indicator units may be estimated by various methods. Various methods tend to give different results. However this is not a serious problem, and may be addressed in the same way as measuring emissions. The uncertainty is estimated and expressed as a distribution function. For some category indicators, the market price may be used to estimate WTP. It may be disputed whether the marked price is what is paid or if various subsidiaries and taxes should be included. For instance, what WTP should be used for crop? Is the world market price that is paid directly better to use than the price the society pays, which mainly is the sum of the buyers costs and the cost for subsidiaries. If we accept to add the cost of subsidiaries we also have to accept the subtraction of taxes if we want to be consequent. However, the goal that

was set up for the EPS system requires the result to be understandable for the designer. This speaks for a choice of a monetary value that is familiar to the designer: the price the buyer has to pay. When studying the market prices you find great variations, partly because there are differences between different regions but also because the category indicators are not sharply defined. Crops include all sorts of crops, like oat, wheat, barley, rice and corn, and their prices vary on the market. These variations are included in the uncertainty measure of the weighting factor.
If there is no direct market, where the indicator value may be found, there are several other methods used for finding the WTP. Some involves studies of behaviour, like the hedonic pricing method, where estate prices are used or like studies of travelling. Both use the extra costs taken to reach a better environment as a measure of the WTP.

A method often used to estimate non-market environmental values is the CVM method. CVM stands for 'Contingent Valuation Method' and is widely used to measure WTP in various groups to various concepts, which are described to them. The CVM technique is based on interviews and is following a special procedure. In the EPS-system the CVM technique is used for category indicators of morbidity and nuisance and for recreation values. The precision of the CVM technique varies. When trying to find the WTP for indicators of the safe guard subject ‘abiotic stock resources', we find that neither the market nor the customers are available to study. You cannot use the CVM technique to determine the WTP for those that are concerned, because most of them belong to future generations. There is no one to ask. To cope with this in the EPS default method, a market scenario was created, where the production cost of substances similar to the abiotic stock resources is used as an estimate of WTP. It is assumed that some of these stock resource materials always will be produced even if the volumes decrease. Consequently there is a will to pay at least it takes, but probably, in the long run, not much more

2.4.1.5 Literature reference

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2. Steen B (1999): A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – Models and data of the default method CPM report Chalmers University of Technology Sweden

2.4.1.6 Methodological range

Geographical range is OECD countries
Time range is 1990~2000

2.4.1.7 Geographical area

-

2.4.1.8 Notes

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2.4.2 Documentation of Weighting factor

2.4.2.1 Reference to the Category indicator.

Crop

2.4.2.2 Reference to Weighting method.
EPS

2.4.2.3 Amount, Category indicator unit, and unit of weighting measure
0.15 ELU/kg

2.4.2.4 Notes
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2.5 Documentation of full Impact assessment

2.5.1 Documentation of Impact assessment method

2.5.1.1 Name, Version
EPS default, 2000

2.5.1.2 Date completed
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2.5.1.3 Principal method name
EPS

2.5.1.4 Method description
This method based on EPS report, includes all the characterisation factors in EPS report.

This method does not include the characterization factor in the characterisation methods with "by oxidation" or "by global warming" phrases etc. ,which were created for the assessment method of LCA-E (EPS/EDP)/2001. Actually they are part of the factors in the corresponding characterization methods without "by..." phrases.

There are two characterisation factors about "Pb air emissions impact on severe nuisance", one for Sweden and the other for the world. Since this method is not only for Sweden, so characterisation factor for the world has been chosen.

2.5.1.5 Literature reference
Steen B (1999a): A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – General system characteristics CPM report Chalmers University of Technology Sweden

Steen B (1999b): A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – Models and data of the default method CPM report Chalmers University of Technology Sweden

2.5.1.6 Methodological range
Geographical Boundary is Europe

Time Boundary: The method is created during 1990-1999

2.5.1.7 Notes

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2.5.2 Documentation of Impact assessment selections

2.5.2.1 Selection of category indicators

Crop

2.5.2.2 Selection of valid inputs and outputs

CO2 emission to air

2.5.2.3 Selection of characterisation parameters

7.56E-4 kg/kg

2.5.2.4 Selection of weighting factors

0.15 ELU/kg

3 References

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